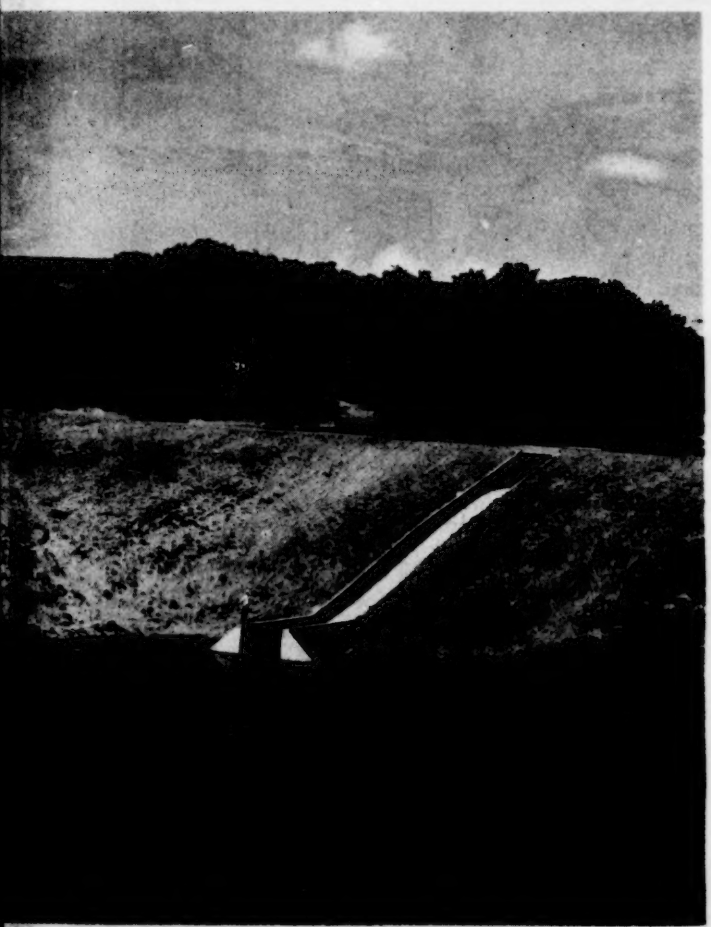

Volume 6, No. 4 **October 1951**

Conservation Farming on Experimental Watershed Increases Farm Income

Are Point Rows Necessary on Terraced Land?

1951 Kansas Flood Area

Livestock and The Land Institute

Criteria for the Evaluation of Conservation Organizations as Interest Groups

Reviews: Land Hunger in Mexico—Practice of Wildlife Conservation

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AT THE TOP OF THE HILL

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Formerly editor of *American Forests*

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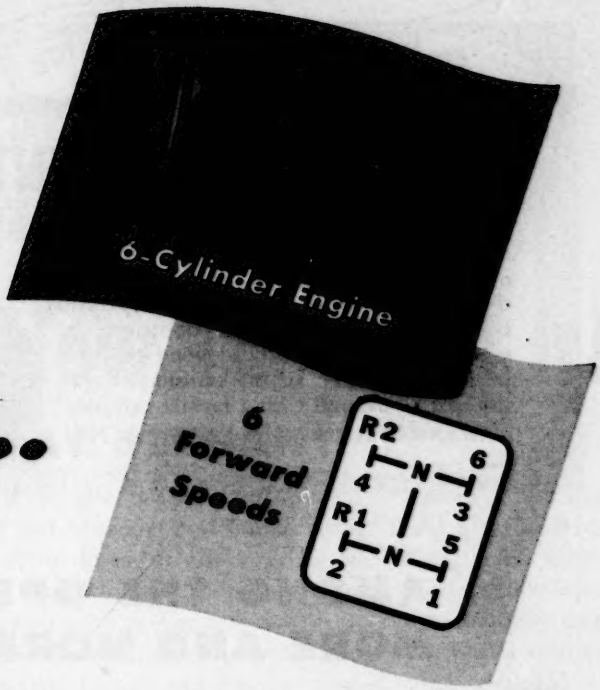

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VOLUME 6
NUMBER 4

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Contents for October, 1951

Resolution—Soil Conservationist as a Critical Occupation 169

County Agricultural Resources Conservation Planning in Illinois 170
E. L. SAUER

Are Point Rows Necessary on Terraced Land? 172
PAUL JACOBSON

Livestock and The Land Institute 175
MELVILLE H. COHEE AND G. D. THORNE

Criteria for the Evaluation of Conservation Organizations as Interest Groups 179
GILBERT BANNER

Soil Management, Soil Sense and Soil Conservation 183
C. L. W. SWANSON

Problems of Drainage in a Soil and Water Conservation Program 185
PAUL J. ZWERMAN

Conservation Effects of Crop Rotation on a Sandy Soil in Vegetable Production 187
O. R. NEAL AND G. D. BRILL

Pictorial Section 191

Factors Affecting Rate of Water Intake in Texas Blacklands 195
WILLIAM R. ELDER

1951 Kansas Flood Area 198
HAROLD J. SWAN

Conservation Farming on Experimental Watershed Increases Farm Income 200
JOHN A. ALLIS

Soil Layers Causing Runoff from Hard-Land Wheat Fields in Colorado and New Mexico 202
C. H. DIEBOLD

Recent Research Reviews 210
JAMES H. STALLINGS

Book Reviews 212

Field Notes and Comments 218

Index—Volume 6, Numbers 1, 2, 3 and 4 223

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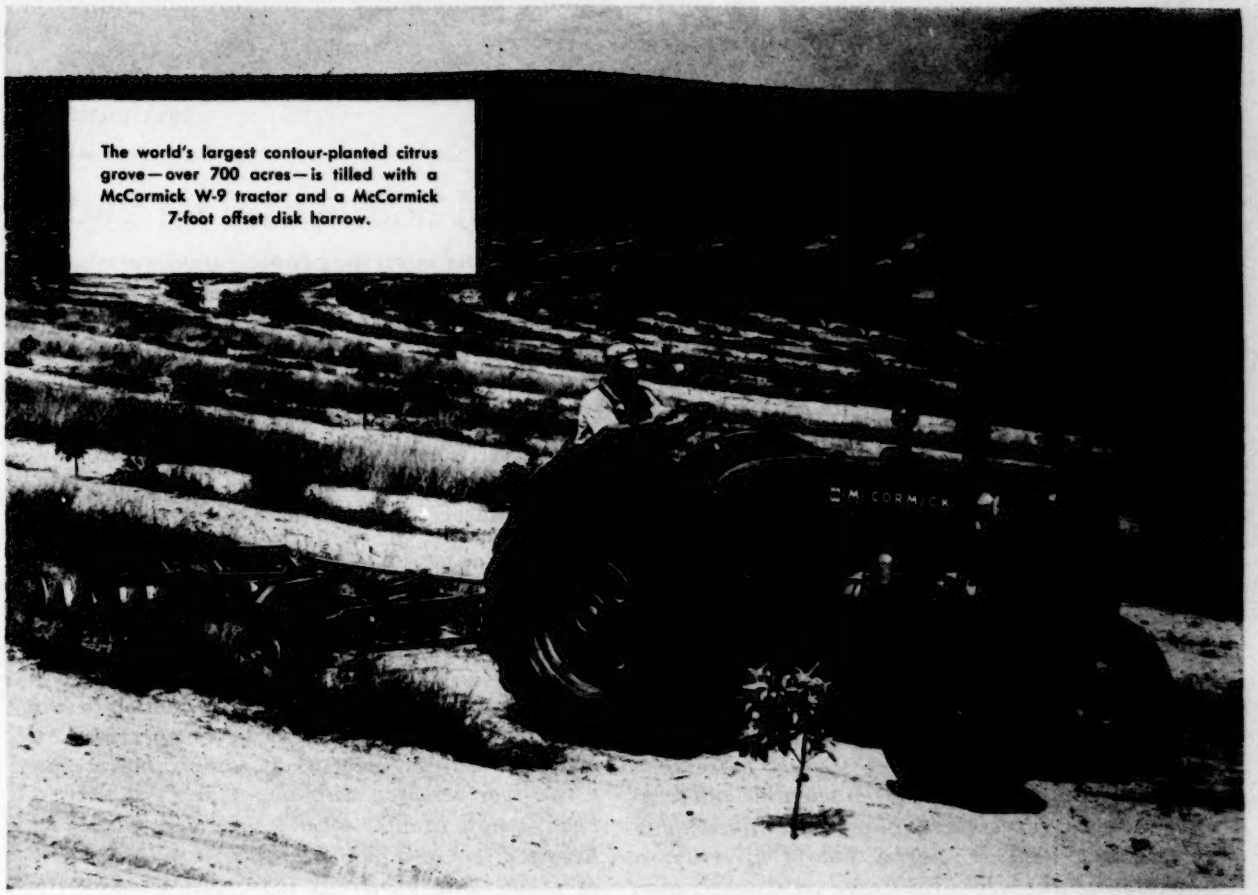
The world's largest contour-planted citrus grove—over 700 acres—is tilled with a McCormick W-9 tractor and a McCormick 7-foot offset disk harrow.

Contoured citrus groves tame Florida sand

Florida climate is ideal for citrus fruit, but sandy soil is often a problem. It squanders moisture, allows costly fertilizer to be leached away, and erodes easily.

Contour planting promises to solve these problems. Progressive growers, working with their soil conservation districts and with the help of the U. S. Soil Conservation Service, are planting orange and grapefruit trees in sand-holding curves. Their new citrus groves look like giant fingerprint markings on the sands of Florida.

The trees in these contour-planted groves make a faster growth than those set out in straight rows. Contouring conserves water and fertilizer—puts the brakes on sand washing. It also reduces production costs because it takes less time and fewer tanks of fuel to cultivate around hills than over them.

Yes, fruit growers, like other farmers, are finding that soil conservation doesn't cost—it pays! This is especially true when they team modern soil-saving methods with field-proved McCormick farm equipment.

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From The Editor

A new and significant conservation group has just been established. It is the Committee on Conservation of Replaceable Resources in the Division of Biology and Agriculture of the National Research Council. The National Research Council was organized in 1916 by the National Academy of Sciences in order "to stimulate research in the mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare." Neither the Council nor the National Academy receives appropriations directly from the government, although the National Academy of Sciences was established by Congressional Charter. The National Research Council has a membership of slightly more than 200 representatives, largely from scientific and technical societies, representatives of Government, and universities. Paul B. Sears, Yale University, is Chairman of the new Committee on Conservation of Replaceable Resources.

Erle Kauffman, who resigned as editor of AMERICAN FORESTS late in 1950, will return to the conservation field this fall as editor and publisher of the CONSERVATION YEARBOOK. Designed as the standard reference guide and directory of American conservation, this new 256-page publication covers the broad field of planned management in renewable natural resources—soil and water, forest and range, wildlife and parks, etc. A sampling of content reveals such features as an up-to-the-minute roster of soil conservation districts, a listing of certified tree farms, and nearly 5,000 names of people in key positions. The YEARBOOK as advertised on page 162 will be issued in January of each year, the first in 1952. Members of the Soil Conservation Society of America, incidentally, are entitled to a 30 per cent discount on the 1952 edition if orders are placed before December 15.

"Down the River" is the title of the Society's new brochure. It is now being printed and will be available for distribution to members of the Society and others at the Memphis meeting—November 12-14. The brochure was developed and prepared by the Business and Organization Relations Committee of the Society headed by H. F. Barrows. Many persons cooperated in writing the brochure which tells a colorful and interesting conservation story beamed to reach urban and industrial groups. The Committee is making plans to distribute several hundred thousand copies of the publication during the next two or three years.

Arrangements have been made with the Suckert Loose-Leaf Cover Company of Detroit, Michigan, to provide members of the Soil Conservation Society of America with a permanent binder for back issues of the JOURNAL. The binder is made of durable imitation leather and sells for $2.75. Each binder holds eight issues. Members are urged to take advantage of the offer which is covered in the Suckert Loose-Leaf Cover Company advertisement.

Members of the SCSA will be interested to know that Dr. C. A. Van Doren, Project Supervisor, SCS Research at the University of Illinois, has accepted a two-year research assignment in Peru. He will head a staff of fifty local technical assistants with headquarters at Tinga Marie, 350 miles northeast of Lima. The project is sponsored jointly by the State Department and the Department of Agriculture. Research will cover horticulture, rubber cultivation, animal husbandry, pathology, entomology, soil and water conservation and extension service to the colonist.

"Land Appreciation" (*Land Judging*) by Edd Roberts, Extension Soil Conservationist for Oklahoma, is the title of a new circular recently issued by Oklahoma A and M College at Stillwater. The circular outlines the steps that are necessary in setting up Land Appreciation Schools. Participants in these schools are taught to appreciate the fact that soil depth, texture, permeability, slope and other factors determine the capability class of the land, and that this classification is the key to using and treating the land properly. The circular also discusses methods of scoring land factors used in the schools. This is an excellent educational project and can easily be adapted to any section of the country.

A "National Conference to Appraise and to Evaluate Our Nation's Progress in Conservation" was the theme of the Eleventh Annual Meeting of Friends of The Land held in Detroit on September 25th. The appraisal covered agriculture, water, forests, fertilizer resources and research. The papers are to be published and may be obtained by writing to Friends of the Land.

An important Resolution

calling for recognition of the occupation of

Soil Conservationist *as* A Critical Occupation

The statement below was recently adopted by and is here published through permission of the newly organized Committee on Conservation of Replaceable Resources of the National Research Council—government's top scientific research body in the National Academy of Sciences, Washington, D. C.

The formation of this new committee, under the chairmanship of Paul B. Sears of Yale University, is important recognition of the growing stature of conservation.

That the National Research Council has championed the importance of the soil conservationist to the continued prosperity and perpetuation of the Nation is an occasion of the utmost significance to conservationists.

WISE MAN-POWER UTILIZATION during the critical years ahead and maintenance of our national agricultural economy, depend upon application of the most modern scientific knowledge in the field of land use and management. Such knowledge is today being made available to land owners and operators by the professional *soil conservationist*. The soil conservationist classifies land according to its capabilities or potentialities for use—parcel by parcel, field by field, farm by farm, watershed by watershed—thus providing a guide for maximum continued yields of cultivated crops, livestock, timber, or other land product and watershed protection values. Soil conservationists have one-third completed a nation-wide survey delineating classes of land according to capability for use. Soil conservationists further provide on-site technical assistance to farmers and ranchers in the application of land treatment methods that help obtain intensive production of adapted crops without damage to the perpetual usefulness of the soil resource and that aid in stabilizing watersheds.

Sustained high production of agricultural products and improved yields depend first of all on use of the land for purposes to which it is suited. Increased production should be achieved without impairment of the basic soil resource. Use of land within its capabilities and treatment of land in accordance with its conservation needs help to preserve our agricultural productivity, and reduce waste of precious manpower, materials and supplies. The professional soil conservationist who provides land owners and operators with scientific assistance in land use and treatment represents a distinctive and essential occupation of critical importance in normal and especially in emergency periods of the nation's existence.

The occupation of soil conservationist has been widely recognized during the past decade. The Civil Service Commission has recognized the profession for years, from the standpoint of job classification and recruitment. Various Federal agencies, many states, industries, colleges, and universities employ soil conservationists. The U. S. Soil Conservation Service depends upon soil conservationists to perform its authorized functions. There is a vigorous organization of professional soil conservationists with more than 4,000 members: The Soil Conservation Society of America. Nineteen American universities offer majors in soil conservation, with more than 50 schools providing individual courses in the subject. Some 2,350 autonomous soil conservation districts, which are organized under state laws in each of the states and territories and undertake soil and water conservation work on farm and ranch lands, depend on professional soil conservationists for technical on-site assistance. Many countries from all parts of the world have sent representatives to the United States to learn what American soil conservationists are doing so they can carry home with them the most advanced concepts in the proper use, protection and improvement of their land resources.

Soil conservation is not a branch of any existing science. In spite of this, various dictionaries and lists of occupational titles still list the soil conservationist as a type of soil scientist, or as a kind of agronomist or other agricultural scientist. *The soil conservationist*

is a land-use and land-management expert, who brings to bear on land-use problems in practical fashion all applicable facts, principles, and techniques from a number of sciences, including soil science, agronomy, biology, engineering, hydrology, forestry, range management, and related subjects. He applies them as coordinated implements of attack, not as individual tools. It is this integrated application of appropriate knowledge derived from many disciplines that distinguishes the soil conservationist and gives balance and effectiveness to his recommendations. The demand for qualified soil conservationists in certain areas already exceeds the supply. Under conditions of continued mobilization the gap between demand and supply will widen. Opportunities for recruitment from the colleges have already become greatly reduced.

THEREFORE, be it resolved that the *Committee on Conservation of Replaceable Resources of the National Research Council* lend its full support for recognition of the occupation of soil conservationist as a separate and independent title, and that it be listed as a critical occupation requiring scientific knowledge and training, so that in emergencies when the soils of the nation might be depleted by misuse of land in response to demands for increased production, the skills of the soil conservationist may be available and employed to make the land even more productive, with less damage to the basic soil resource.

County Agricultural Resources Conservation Planning in Illinois

E. L. SAUER

The U. S. Department of Agriculture Memorandum No. 1278 provides for formulation of a county agricultural resources conservation program in each county. The Illinois state agricultural resources conservation group decided that the county agricultural conservation program should be designed for the maximum development and protection of agricultural resources and for using of these resources in such a way as to continue to get maximum production in a manner profitable to the farmer.

A STATE COMMITTEE on "productive capacity studies of Illinois agriculture," under the leadership of Dr. H. C. M. Case, Head, University of Illinois Department of Agricultural Economics, and composed of representatives of the Illinois Agricultural Experiment Station, Extension Service, Soil Conservation Service, and the Bureau of Agricultural Economics, has been carrying on intermittently since 1935 studies of the productive capacity of Illinois agriculture. This committee, realizing the problems facing the county ARCP committees in developing a sound soil and water conservation program, summarized and analyzed data which would be of help at the county level in planning for desirable land use, crop rotations, fertility improvement, and ersoion control practices. Five area reports were prepared. They contained county and state data on historical and present land use, crop yields, and soil conditions, and an area example of planning at the county level.

The intensity of present land use is a major problem in Illinois. For the five-year period, 1945-49, more than 70 per cent of the cropland in six counties was planted to the two intertilled crops, corn and soybeans. A considerable number of counties in this central Illinois cash-grain area averaged less than 12 percent of their cropland in hay and pasture. Historical data by counties plus the 1951 guides for crop production show many central Illinois counties are using their land in such a manner that soil fertility depletion and erosion are occuring at an accelerated rate.

Planning Based on Soils Inventory

Soil survey reports have been published for 73 of the 102 counties in Illinois. Ten of these reports are comparatively recent and contain up-to-date soils information. In addition, 28 counties have been mapped or adequate soil survey examples have been taken to compute soils, slope and erosion data for the county. With this available soils data, land-use capabilities and a long-time recommended land-use program were computed and

projected for each county of the state. The recommended land use was based on approved rotations by land-use capabilities, assuming soil treatment and use of erosion control practices in accordance with needs. The recommended rotations show the most intensive cropping system that would be suitable for each soil association area of each county considering type of soil, slope, degree of erosion, and present depth of topsoil. This recommended long-time land-use pattern for the state calls for a maximum of 43 per cent of cropland to be used for intertilled crops, 22 per cent for small grains, and a minimum of 35 per cent for meadow (hay and rotation pasture). At the present time, approximately 54 per cent of Illinois' cropland is in intertilled crops, 22 per cent in small grains, four per cent idle, and only 20 per cent in meadow. A wide difference exists between recommended and present land use in many of the individual counties. One central Illinois county has only seven per cent of its cropland in meadow whereas a desirable land-use pattern calls for a minimum of 28 per cent in meadow.

The area examples of planning at the county level show a soil association map for a sample county, the per cent of the county in each soil association area and slope group. Desirable conservation practices by soil association areas are also shown along with the most intensive cropping systems suitable for each soil association area by per cent and length of slope. The rotation recommendations assume soil fertility treatment and erosion control practices in accordance with needs. For instance, on the best Illinois soils being predominantly nearly level, the recommendations call for a four-year rotation consisting of two years of intertilled crops, one year of small grains, and one of meadow. On these same soils but having an average slope of three per cent, recommendations call for a five-year rotation if no practices are used (two years intertilled, one year small grain, two years meadow). If terracing were used on this slope group, the rotation would be a four-year one with 50 per cent of the land in intertilled crops and 25 per cent in meadow.

E. L. Sauer, a Charter Member of the SCSA, is Research Project Supervisor, Soil Conservation Service, with headquarters at the University of Illinois, Urbana, Illinois. Mr. Sauer, in cooperation with the Illinois State Experiment Station, is one of three agricultural economists in the United States working full-time on problems of the economics of conservation.

Activating Results of ARCP Study

The area reports were presented at five meetings in Illinois to a select group from each county (county agent, PMA chairman, soil conservation technician, and chairman of the county soil conservation district board of directors). This county group, with the asssitance of other local leaders, are preparing a county agricultural resources conservation program to fit their local conditions and needs. These county programs should serve as a basis for carrying on the conservation work in the county. A desired objective is the direction of the individual programs of each agency toward achieving the goal of the over-all county agricultural resources conservation program.

The ARCP program, as carried out in Illinois, has been helpful in getting farmers and farm leaders at both the state and local level to think about their conservation and fertility improvement problems. Many now see that to increase agricultural production in line with defense needs and a growing population, more consideration needs to be given to erosion control and improving soil and water resources. There is a growing awareness of the fact that increasing acreages of grain and other soil-depleting crops will not increase over-all production. Instead, acreage goals may need to be reduced in favor of concentrating on improving the productivity of the land that is in production. Examples in the five area reports showed that production per farm and per acre could be increased under varying circumstances from 10 to over 50 per cent by using the land according to its capabilities and by following sound rotations with ample acreages of legumes and grasses plus the application of minerals in accordance with needs and the use of proper erosion control practices. In other words, a sound soil conservation and fertility improvement program is the best answer to increasing agricultural production.

The ecology of a whole river valley can be wrecked by a few decades of forest cutting and one-crop farming. . . . Floods, soil erosion, silting, stream pollution, forest fires, dust storms will overwhelm even the gains of mass production. In due course they can send a great watershed into physical bankruptcy—which is a good deal worse than the paper kind. Then the people learn that they too are a part of nature. Eroded soils erode the temper of those who try to wring a living from them; conflicts and frustrations mount with their poverty.

—STEUART CHASE, *Excerpt from* ***Roads to Agreement,*** *page 172*

Are Point Rows Necessary on Terraced Land?

PAUL JACOBSON

One of the farmer's greatest objections to terraces is the great number of point rows which occur between terraces at frequent intervals along the length. By using the methods explained in the article a great number of these point rows can be eliminated. It takes rather uniform topography to make all terraces parallel in a system, but parts of every terrace job can be made parallel if methods outlined in the article are used in layout.

SINCE MANGUM BUILT his first broad base terrace in 1885 in North Carolina farmers and technicians have tended to stumble along in tradition and looked only to the methods of laying them out rather than to the job the farmer will have in the future in farming them. A careful analysis of terraces will reveal that if properly constructed and maintained they will stand up permanently and continuously serve man. Therefore, the technician who lays out a set of terraces should rate farmability just as important as the specifications.

Now any farmer will tell you that terraces are all right but he hates to farm all those point rows. We can now assure him that in a great many cases point rows are not necessary.

During the last four or five years farmers in various parts of the Midwest, with the aid of Soil Conservation Service technicians, have been planning and building parallel terrace systems. Technicians who have started to lay out parallel terraces often have been surprised to find that, with a little planning, parallel terraces can be built on slopes where there is considerable variation in topography. Even the strongest advocates of parallel terraces have thought that they were limited to the unusually uniform slopes, but now they find that many terrace systems can be improved by using this method. Even though the entire system cannot be made parallel, some of the terraces or parts of some terraces or pairs of terraces may be arranged in this manner.

The technique to making terraces parallel on non-uniform slopes is:

1. **To outlet the terraces in most of the natural waterways. This will mean cresting the terraces on the ridges between outlets which in itself will help the drainage of all the rows between terraces and tend to make the terraces parallel.**
2. **To allow the terrace grades to vary along the length of the terrace. Observation and analysis of research data indicate that if adequate rotations are followed, considerable slope (more than we originally considered possible) can be allowed for short distances in terrace channels without serious soil losses. It should always be emphasized that the average grade should not exceed the allowable grade for the area.**

Thus we can say that with a little more time spent in planning, and by using some variations in grade, many of the point rows in a number of terrace systems can be eliminated.

Grade Becomes Over-all Control Figure

In the past we have been concerned about maintaining uniform grades. If the slopes of a field do not vary over a couple of per cent, terraces can generally be kept parallel by varying the grade within the terrace rather than by varying the horizontal interval. Grades will tend to become uniform throughout the length after the terraces have been in use for a few years. The problem then becomes one of considering the total fall from one end of a terrace to the other. A. W. Zingg, in a summary of tests run at the Bethany, Missouri, Experiment Station, stated in his summary that channel grades up to six inches fall per 100 feet may be safely used on the Shelby soils which are typical of that area. This grade then becomes the over-all control figure, and it might be increased or decreased for a given soil type according to the intensity at which it is to be farmed. We can, therefore, allow considerable variation from the allowable over-all grade in a short section of terrace without fear of an undesirable outcome.

Paul Jacobson, a member of the SCSA, is zone conservationist, Soil Conservation Service, with headquarters at Milwaukee, Wisconsin. He assists technicians on engineering problems in northern Iowa and southern Minnesota.

Depth of water in feet required for various amounts of runoff and related grades in channel

	Terrace channel grade (per cent)						
	0.2	0.4	0.6	0.8	1.0	1.5	2.0
	Depth of water (feet)						
Runoff c.f.s.							
2	0.4	0.3	0.3	0.3	0.2	0.2	0.1
3	0.5	0.4	0.4	0.3	0.3	0.3	0.2
5	0.6	0.5	0.5	0.5	0.4	0.4	0.4
10	0.9	0.8	0.7	0.6	0.6	0.6	0.5
	[1] 1 ft/sec. —		Velocity	—	2 ft/sec.		

[1] The figures to the left of the first stepped line represent velocities of less than one foot/second. Those between the lines represent velocities of one to two feet/second, and those to the right represent velocities over two feet/second.

The above table gives terrace channel grade, runoff, depth of water, and velocity for a terrace with six-foot bottom and 4:1 side slopes. If we assume that we get runoff of from three to five cubic feet per second from each acre, and that a safe velocity for bare soil is about two feet per second, it is easy to see from the table that on terraces not over 600 to 800 feet in length, grades for short sections as high as one per cent are not going to cause serious erosion.

Example:

Terrace length 600 feet

Terrace spacing 70 feet

Area between terraces 42,000 square feet or approximately one acre

Assume runoff of five cubic feet/second/acre

Then, since area is one acre, total runoff equals five cubic feet/second

From the table, using five cubic feet/second, and a channel grade of 0.8 per cent, the depth of flow would be 0.5 feet and the velocity about 1.5 feet per second.

Again we must emphasize that the over-all average grade is the important item to consider, which means that if a one per cent grade is used for a one-hundred foot section it must be offset by a one-hundred foot flat section or an equal section with very little grade.

If we analyze the above statement, we find that we are letting nature (over a period of time) do an earth moving job for us that permits the construction of parallel terraces. Water will move soil from that part of the terrace with the steepest grade and deposit it on the flatter portions until we finally have a fairly uniform grade from one end to the other. Where grades are such that velocities do not exceed the two foot per second previously mentioned, field observations on a number of sets indicate that this soil movement is so slow that ordinary annual maintenance, which consists of backfurrowing to the terrace ridge, is sufficient to maintain the terraces.

Method of Terrace Layout Important

If it appears that parallel terraces are reasonably feasible on a given site, the next question is the proper method of layout. The first step is to determine several terrace intervals. (See Figure 1.) Since topography of the field must be reasonably uniform, if parallel terraces are to be used, this resolves itself into a simple procedure. Usually the best place to set up the interval stakes is about the middle of the slope to be terraced, or at a critical point as indicated by the erosion pattern. The location of the top terrace is determined in the conventional way of reading slopes and determining the proper vertical interval. The intervals for terraces two and three are similarly set by determining the proper vertical interval for each successive terrace based on average slope and a stake is set to mark each terrace.

Now you are ready to select a key terrace. Usually it is well to use terrace number two or three as the key terrace. The one actually used will depend primarily on the uniformity of slope and its selection will mainly be based on experience in terrace staking.

The next step is to stake the key terrace. This is done by staking each way from the interval stake which was previously set. It is usually easier to use a uniform grade in staking the key terrace. On soils which take water readily this can be about 0.3 foot per 100 feet, and on tight soils this probably should be increased to 0.5 foot per 100 feet.

The third step is to use a chain and determine from the original interval stakes the horizontal interval between terraces. Starting at the outlet end the other terraces are staked parallel to the key terrace. Stakes should be set at 50 or 100 feet along terrace lines, depending on the uniformity of slope along the line. As these stakes are being set, or after they are set, elevation should be read to determine whether or not the terraces above and below the key terrace will drain. Sometimes it will be necessary to shift the location of the key terrace slightly, as well as others above and below it, to prevent excessive grade or back-fall in one of the terraces.

The method of layout is well illustrated by steps in Figure 1.

In laying out parallel terraces one will often find a short section of a terrace where, in order to maintain the whole system parallel, it is necessary to make a cut of four or five tenths of a foot. (A cut greater than this should not be made.) If the farmer is given his choice of making this cut or of varying the distance between terraces, he will more often decide to make the cut. In other words, he makes the determination that a few extra hours' work at the present is more desirable than to farm point rows for the next 20 to 30 years. This, again, can be considered as one of the many steps one

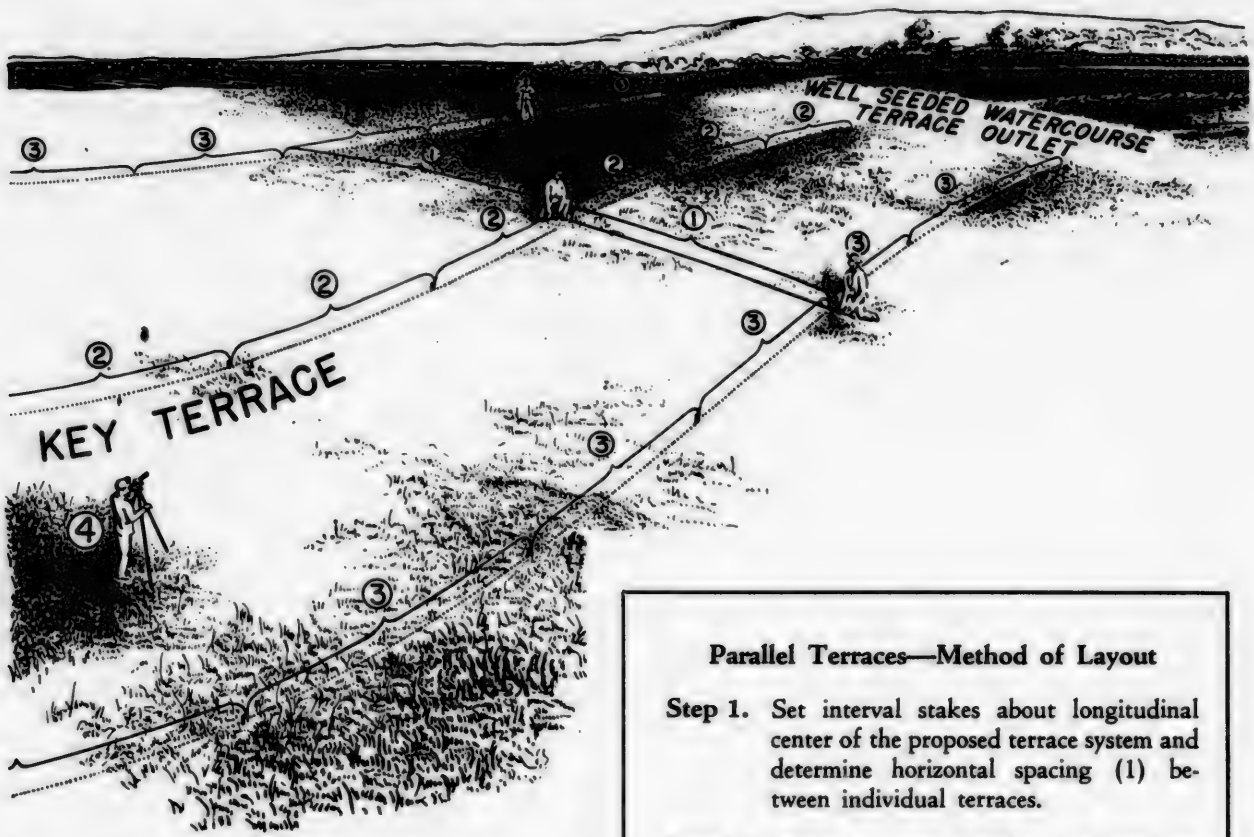

Figure 1. This sketch shows terrace spacing and gradient of the key terrace. Parallel terraces are established according to local specifications as developed by soil conservation technicians. If the slopes of a field do not vary over a couple of per cent, terraces can generally be kept parallel by varying grade within the terrace rather than by varying the horizontal interval.

must analyze in building terraces for the future. Is it more desirable to save work and cost in immediate construction, or should we increase construction costs in the present to make farming operations less difficult in the future? If it is left up to the farmer, he will quite often decide to increase the cost and move the dirt so as to permit the many years of easier farming.

Summary

1. **Parallel terraces are possible where the slope does not vary over two or three per cent.**

2. **By applying this method to all terrace systems, some point rows can be eliminated in all of them. This will greatly reduce the percentage of point rows in the whole field and simplify the farming of the field.**

3. **The best map of a sloping field is the field itself and this method of layout uses the field as a map and gives a ready method for analyzing the field by a few check lines to determine whether or not terraces on parts or all of the field can be laid parallel.**

Parallel Terraces—Method of Layout

Step 1. Set interval stakes about longitudinal center of the proposed terrace system and determine horizontal spacing (1) between individual terraces.

Step 2. Choose key terrace and stake channel on grade at 50'-100' intervals (2). The average slopes of the area involved and the experience of the planner in laying out terrace systems will serve as a guide in the selection of the key terrace.

Step 3. Beginning at the terrace outlet—lay out other terraces, using chain to establish horizontal spacings (3) between terraces as determined under step (1).

Step 4. Read elevations at stakes on terraces laid out under (3) and adjust all terraces so that they will drain into the outlet without excessive grades.

Livestock and the Land Institute

MELVILLE H. COHEE AND G. B. THORNE

The Iowa-Minnesota Livestock and The Land Institute, an event very much out of the ordinary, has proven itself in the middlewest. It has aroused tremendous interest in good land use and quality meat production on the part of farmers and many other agricultural forces. The Institute, sponsored by ten organizations, is also an excellent example of cooperation between farmers, farm organizations and federal and state agencies.

EMPHASIS IS SHIFTED a little each year as to livestock enterprises but always keeping their relationship to good land use as the central theme. At the September 26, 1950 event, beef cattle, starting with feeder calves, was high-lighted. This year, also on September 26, the Institute featured the native beef cow herd and its natural combination with grass and roughages. Farmers showed their interest in the Institute by attending 5000 strong last year with 6000 in 1951. Some farm leaders have branded this unusual means of pulling many objectives and interests into common focus as "*the greatest thing that has ever taken place in this part of the country.*"

Among other things, live cattle and realistic exhibits are used to illustrate each important point covered at the Institute. Picture an authority in his field covering the subject "Which Cattle Should I Use?" and the separate but quick entrance and exit of five different lots of feeder cattle or beef cows! Let your mind catch the theme of "Filling the Consumer Order," and visualize a row of dressed carcasses, fresh from the coolers, and the speaker's assistant pointing to the cut locations, meat finish, and the like on the side of beef being discussed. Furthermore, a nearby building is entirely filled with special exhibits, mural type of photo enlargements, and numerous displays on important aspects of beef production and soil management.

The program is all inclusive in that two farmers, speaking from a fact moving series of colored slides, tell about their own farm operations. They tell how and why they did what they did and about the problems as they have experienced them in arriving at a practical and economical land use and livestock system of farming of the type being featured throughout the entire program.

Higher consumer demand for meat and an appreciation of higher quality meat, coupled with recognition of forage as an economical means of producing livestock, can help speed up the application of soil conservation farming on a sound land-use basis. Farmers frequently ask how they can market the increased forages resulting from modern conservation farming. They are realizing that land unsuited to rotation cropping can be made to produce more when put into meadow. It also is true that yields of row crops can be increased by the use of more meadow in the rotation.

Many times, however, the full benefits from such conservation practices are only realized when the livestock on a farm is fitted to the feed-supply pattern. The first considerations in developing a good livestock system are the feed supply that will result from the crop rotations, and the land uses that will maintain productivity and control erosion. Availability of feeds and pasture during different periods and seasons throughout the year are extremely important factors.

Each Crop Has its Proper Place

The fact that long yearling will make daily gains of 1.5 lb. to 2.0 lb. or more on good legume-grass meadows in the spring and early summer is not easily grasped by farmers used to heavy grain feeding only in dry lots. Equally difficult to appreciate is the fact that meadows, when marketed through proper live-

Figure 1. Forage crops, pasture improvement, and other conservation measures were promoted in the Institute Clinic.

Melville H. Cohee, a Charter Member and first Secretary of the SCSA, is Chief of the Project Plans Division for the Soil Conservation Service. His headquarters are in Milwaukee, Wisconsin. G. B. Thorne is associated with Wilson and Company, Chicago, Illinois.

stock feeding and management systems, can hold their own with grain crops in net returns. The complementary aspects of row crops, small grain crops, and meadow and permanent pasture crops in the livestock feeding systems also need to be given wide interpretation among farmers. Whether a good alfalfa-bromegrass pasture is inferior or better than an equal area of corn on a farm, or vice versa, may be relatively unimportant, since each crop on the contrary, has its proper place in the conservation farming program for the farm.

It was in this setting that the Iowa-Minnesota *Livestock and The Land Institute* was conceived and established. The first was held on September 26, 1950, and the second was held on the same date, 1951. It was felt that through a carefully planned Institute, scientific findings and practical experiences in applying them could be emphasized to all farmers. Furthermore, it was felt that in addition to farmers themselves, the interests of many agencies in land and livestock could well be pooled in sponsoring the Institute. The Institute would be a coordinating activity.

Southern Minnesota and northern Iowa was chosen as the setting for the Livestock and The Land Institute. The area is well suited for needed land treatments which also produce feed supplies that may be fed profitably in the existing livestock enterprises.

Facilities of the Wilson & Co., packing firm, were available at Albert Lea, Minn. Ten sponsoring agencies in Iowa and Minnesota were: The two State Farm Bureaus, the two State Associations of Soil Conservation Districts, the two State Agriculture Extension Services, the U. S. Soil Conservation Service, Wilson & Co., Iowa Beef Producers Association, and Minnesota Livestock Breeders Association. Executive, clinic, and publicity committees were established to plan and conduct the institute.

The first two annual programs have featured national authorities on various beef production and land use subjects. A highligh was a first hand report from an Iowa and a Minnesota farmer on how they managed their beef herds and fed their cattle. They gave a running account of wintering with plenty of quality forages and grain feeding on legume-grass mixture pastures. Cattle from their farms were on hand for inspection.

These farmers had been selected as typical of thousands who also could follow their example of conservation farming and beef production. Both farmers cooperating with the Institute in 1950 had purchased mixed lots of steer and heifer feeder calves in the previous fall and wintered them on forages plus very light daily grain rations. Mr. J. E. Sells, Luverne, Minn., used grass silage in his wintering ration, pastured 73 days before starting his grain feeding on pasture, and had the steers in dry lot for 30 days before marketing. Mr. William Darbyshire, Rockwell City, Iowa used legume-grass for his forage feed during the winter and grain fed his cattle all the time they were on pasture, marketing his steers directly off the pasture. Data in Table 1 give the story of the two farmers' ex-

Table 1.—Feeding Information for Steers
(Sells and Darbyshire Farms)[1]

	Sells Cattle Minnesota	Darbyshire Cattle Iowa
1. Cattle purchased	Oct. 14, 1949	Oct. 5, 1949
2. Cattle marketed	Oct. 10, 1950	Oct. 18, 1950
3. Days on farm	361	379
4. Starting weight, lbs.	395	415
5. Ending weight, lbs.	950	1072
6. Total gain, lbs.	555	657
7. Average daily gain, lbs.	1.51 (361 da.)	1.74 (379 da.)
8. *All* feed costs per lb. of gain, cents	14.9	15.4
9. Days on pasture	98	167
10. Animal pasture *days* per acre	194	369
11. Pounds of beef gained *per animal* from each acre of pasture	123	120
12. Pounds of beef produced from each acre of pasture	242	279
13. Value of acre of pasture as hay	$42.50	$51.00
14. Value of beef gains from each acre of pasture	$70.78	$85.10
15. Pasture cost per animal day of 1950 pasture, cents	22	13.8
16.[2] Cost per lb. gain from 1950 pasture, cents	17.5	19.2
17. Cost per lb. gain from non-pasture feeds *after* wintering period until cattle sold, cents	19.7	20.7
18.[3] Cost per lb. gain from all other feeds than 1950 pasture, while cattle on farm, cents	14.1	14.5
19. Total corn per animal, bu.	21.1	34.9
20. Total oats per animal, bu.	6.6	0
21. Total protein suppl. per animal, lbs.	172	174
22. Total alf-brome hay per animal, lbs.	886	1937
23. Total alf.-brome silage per animal, lbs.	2100	0
24. Bushels of corn, or grain equiv., per 100 lb. gain	4.4	5.3
25. (Dry lot steer) bushels of corn, or grain equiv., per 100 lb. gain	6.0	.....
26. Carcass yield percentage (pastured steers)	59.1	60.2
27. Carcass grades (old standards pre 12/29/50)	15 G. 23-Comm.	22-G, 9-Comm.

[1]Both farmers had mixed herds of steer and heifer feeder calves at the beginning of the feeding period. Weights, feed, and pasture information were kept separately to provide data herein; the heifers were marketed earlier than the steers; both farmers had their heifers on dry-lot feeding before marketing.

[2]These data should not be confused with seemingly similar data for other studies which represent total *gain* divided into pasture cost, rather than separate gains *from* pasture and gains *from* grain and then divided: Technique developed by Joint Committee of American Soc. of Agronomy, Am. Dairy Science Assoc., and Am. Soc. of Animal Production (see *Journal of Dairy Science*, April 1943, Vol. XXVII, pages 353-369) was used to determine separations.

[3]Costs per pound of gain are cheaper during the wintering period when the feeder calves are growing fast and quality roughages make up the large part of their ration.

Figure 2. Farmers observe the process of soil erosion and damages to the land. Charts and other visual aids were used to help tell the story.

periences. Mr. Sells fed a few head of cattle entirely in the dry lot—no pasture—in order to obtain information for comparison with his pasture feeding results (item 25). Information in Table 1 includes no costs for labor, housing, interest and the like; nor does it include any return item for manure.

Two years of legume-grass meadows figure in rotations on both farms. The first-year meadow crop is used for hay or silage and the second-year meadow is pastured or otherwise harvested as the yields and livestock needs dictate. Mr. Sells follows a six-year rotation of corn, grain, corn, grain, meadow, pasture. His land is moderately rolling and he operates it with a 5-mile system of terraces and a complete pattern of contouring. Mr. Darbyshire operates land with little slope but having a drainage problem. His rotation is corn, corn, grain, meadow, pasture. Both farmers are soil conservation district cooperators.

For many years these two farmers have kept good farm-account records with accurate inventories. It was only a matter of studying the facts to trace their shifts in livestock enterprises, made to keep in pace and in tune with their improved land use and the feed supplies produced. From data and information in Table 2, it is readily apparent that in a five to six-year period, both farms had very large increases in annual production over previous years. Both farmers have stocked livestock to the capacity of forage and pasture feed supplies.

Mr. Sells has doubled his cattle and hog production. Mr. Darbyshire has increased his beef production nearly seven fold while keeping about the same hog production and dropping his small sheep and dairy enterprises. Both farmers now harvest a small acreage of bromegrass seed each year.

Table 2.—General Farm Information

	Sells Farm Minnesota		Darbyshire Farm Iowa	
1. Size of farm, acres	320		280	
In crops, acres	294		264	
2. Topography	Rolling		More level	
3. Land capability classes	Mostly II, some III a little I and IV		Mostly I and II, a little III	
4. Prevailing slopes	3-5% — a little up to 11 and 13%		Mostly 1%, some up to 3%, a few depressional spots	
5. Present crop rotation	C-G-C-G-M-P		C-C-G-M-P	
6. Livestock and products	(Years)		(Years)	
	1943[1]	*1949*	1941 *1942*	1948 *1949*
a. Cattle, pounds	18,265	37,837	4,474	28,822
b. Hogs, pounds	20,990	45,545	28,460	26,408
c. Butterfat, pounds	1,467	602	1,340	255
d. Sheep, pounds	None	None	1,500	None
7. Crop production (+) = surplus produced over what fed, (—) = amount fed over that grown				
a. Hay, tons	+ 35	+ 6	+ 6	+ 31
b. Corn, bu.	—1000	—3600	+4344	+2872
c. Oats, bu.	— 300	— 700	+ 371	+1112
d. Soybeans, bu.	None	None	+ 277	+ 322
e. Protein suppl. and other mill feed, tons	—1¾	—17½	— 5	—7-2/3
f. Grass silage	+50	—25[2]	None	None
8. Acres pastured by cattle, year 1950	27		36	
9. Steers and heifers pastured	Same field		Separate fields	

[1]Mr. Sells had a beef cow herd; he also used mainly horses rather than tractor for power.
[2]Carried over from 1948.

Summary

General conclusions possible from data presented in Tables 1 and 2, and from other information available on the farm operations, are:

1. Physical production on the farms increased with establishment of the farm conservation plans.

2. Both systems of handling the feeding cattle illustrate a good way to utilize available feeds produced by

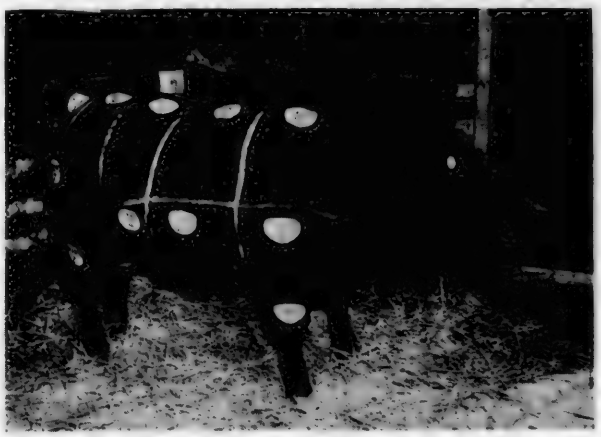

Figure 3. Cuts of quality meat—the animal will yield are indicated—thereby relating the end product to conservation measures on the land.

conservation farming. There are several other systems; however, these two farmers have the ones that fit their particular conditions.

3. When pasture feed is figured at reasonable costs on the basis of alternative use as hay, the feed costs per pound of beef gain are not exceptionally lower in favor of pasture without grain feeding. Too often, cheap costs of beef gains are claimed from pasture when actually the pasture feed values used are too low.

4. Values for the pasture part of feeds consumed were 66 per cent greater in terms of gains times market price of the beef, than the value figured on the basis of sales price for unharvested hay times normal yields. Although this is favorable to pasture as a good way of marketing, such greater values can be misleading without similar consideration to other feeds. For the same period—namely, from start of grazing to marketing date of cattle—all feeds other than pasture showed around a 50 per cent greater value for feeds marketed as beef over current (1950) cost prices for the feed. To illustrate, therefore, $1 of pasture brought $1.66 in beef produced for both farmers. One dollar of other feed used after the start of the grazing period brought $1.52 for Mr. Sells and $1.47 for Mr. Darbyshire in beef produced. (This is purely gross costs and returns for the feeds; no expenses for investment, labor, etc., are included). For Mr. Sells' dry-lot cattle, for the same period, there was a 61 per cent greater return for value of beef produced over feed costs.

5. The charge for a day (or other period of time) of pasture in itself is no indicator of what can be expected in cost per pound of beef gain. This is also true with regard to charges for an acre of pasture. The quality of pasture, carrying capacity and rate of stocking, and system of grain feeding (if any) must all be taken into account in analysis of results and cost per pound of gain.

Furthermore, the condition of the animal as affecting selling price comes into the picture. It may be noted from the data presented that although Mr. Sells' cost per animal day of pasture was 22 cents compared to 13.8 cents for Mr. Darbyshire, the cost per pound of beef from their pastures alone was not greatly different. This circumstance resulted from a combination of factors. Although the pastures were about equal in quality, Mr. Sells' pasture appeared to be overstocked during the first part of the grazing season and not used to capacity during the latter part of the summer. Mr. Darbyshire used his pasture to capacity throughout the season and supplemented it with grain feeding. Climatic conditions played a part in these comparisons, also, since there was a period of extreme dry weather in Mr. Sell's community in the middle of summer.

Favorable reports of the 1951 Livestock and The Land Institute are coming in as this article goes to press. Just as was done in 1950, the two farmers, as well as others, vividly illustrated the significance of beef cattle to the advancement of soil and water conservation. Mr. Dwain Blake, who farms 383 acres near Webster City, Iowa has a herd of 47 Herefords. He told about the feeding and mangament of his herd and how he uses large amounts of improved pastures, hay, and alfalfa-bromegrass silage, thus making it practical and economical for him to have a four year rotation of corn, grain, meadow and pasture on his highly productive cropland. His erosion problems have disappeared and his yields per acre are considerably greater than with a more intensive farming system. He is truly practicing what he advocates as a Commissioner in the Hamilton County, Iowa, Soil Conservation District.

Mr. Herbert Johnson, with his 280 acre farm near Hadley, Minnesota, related similar experiences for his 27 head of Angus beef cows.

These two farmers at this year's Institute gave factual data on costs to raise their beef calves. Exclusive of labor and housing, all other costs placed the price per pound of feeder calf at around 20 to 23 cents. This sheds light on the perennial question as to whether so-called high priced corn-belt land can be used profitably to maintain beef herds and produce feeder cattle. When the midwest farmer inventories his land needs, establishes cropping, pasture and conservation practice patterns accordingly, and then fits his livestock programs to the feed supplies available, almost invariably he has an efficient farm organization. The land use and livestock are fitted together with complementary benefits to each other. This followed naturally the opening keynote statement on land use at the 1951 Institute, "Your Land and You."

"So far as the world's food is concerned, all peoples must learn together to make proper use of the earth on which we live. Hovering even now over our shoulders is a specter as sinister as the atomic bomb because it could depopulate the earth and destroy our cities. This creeping terror is the wastage of the world's natural resources and particularly the criminal exploitation of the soil. What will it profit us to achieve the H-bomb and survive that tragedy or triumph if the generations that succeed us must starve in a world, because of our misuse, grown barren as the mountains of the moon?"—**GENERAL DWIGHT D. EISENHOWER in a speech at Columbia University, March 23, 1950.**

Criteria for the Evaluation of Conservation Organizations as Interest Groups

GILBERT BANNER

Conservation of natural resources has been entering a new period, a period which might be called the period of formal conservation education. The country has passed through several phases in the conservation of natural resources. First was that of the early pioneers in the movement, who helped coin the word, and who pointed out its need to an unheeding society. Next was added the weight of the private conservation organizations. Then came the resource-experts, the professional conservationists of the governmental departments. Now the educational specialists are taking conservation into the schools to be taught at all levels.

DURING THIS DEVELOPMENT there has been a change of emphasis, a broadening of interests starting with forestry, and with the addition in turn of wildlife, soils, water, etc. There has been a change of emphasis from conservation of single resources toward comprehensive land-use planning. At present we are in a period of large-scale construction of river and land projects.

Other outstanding characteristics of today are a great development of energy resources, an accelerating use of all resources due to advances in technology and increasing productive capacity, and an increasing conflict between different private interests as needs for resources increase. The businessman has become resource conscious as industry feels the pinch of scarcity and he recognizes that his future supplies look short.

Concern has developed in some quarters over world-wide problems of man's pressure on the environment in the light of increased resource use and increasing world population. Cooperative actions by international organizations on world resource problems have been undertaken.

Conservation Organizations Must Lead

In view of these conditions, **where do the private conservation organizations stand today? Is there greater need than ever for these groups to be vigilant in the interests of society? Have they been meeting the requirements of present day conditions?**

There is no question as to the need for these organizations to give clear leadership in obtaining desirable conservation policy, and to educate the public in the values that may be obtained from intelligent use of our resources, for we cannot wait for the fruits of educating our children alone. With ever-increasing pressure due to our expanding economy, the need for conservation practice grows greater in spite of many gains.

Since these organizations exist not only for general educative purposes, but also to effect changes in the way that natural resources are used, and do so in the interests of the entire people of the country, they may be evaluated as interest-groups. The interest-group, a socio-political phenomenon of importance in this country, is formed to protect the interests of citizens who feel that concerted pressure on their part will make more likely changes in the attitudes and the behavior of people or the promulgation of their point of view in legislation.

In our democratic political organization, the formal government is not able to represent all the special interests which exist in our complex society. Groups form to act in behalf of these interests. Their aim is to affect public policy by influencing directly or indirectly those in power. Interest-groups have evolved to channel expression and present demands and criticisms more effectively for those who feel alike on certain issues. These organizations for expressing interest-opinion are an important part of our present democratic process of government.

The objectives of interest-groups are to reflect and create the opinion of their membership, voice effectively the group policy, build up favorable public opinion, and influence governmental action in their favor. Since individual voters are the ultimate measure of potential power in our form of government, interest-groups (unless they have important political connections and economic power) must either get large membership for their organization or have public opinion in sympathy with their aims.

They are political groups if they place candidates for office, back officially one or another candidate in an election, back the actions of a political party, or other-

Mr. Gilbert Banner, a Member of the SCSA, is a doctral student in Conservation at the University of Michigan School of Natural Resources, Ann Arbor, Michigan. He holds degrees in Forestry, Conservation and Education. Mr. Banner is especially interested in Natural Resources Conservation and Education, and plans to teach in this field.

wise take a stand on political issues. All interest-groups have political power and often are recognized as power points by the political parties. There is practically no action that an organization can take that is not political in its implications and partisan to some political arrangement. Whether an organization is political or not is an academic question of definition. *The closer an individual comes to asuming the responsibilities which are his as a citizen, the closer are his activities political.*

Factors to Consider in Evaluating an Organization

Study of interest-groups in this country shows that once an interest-group forms, it carries on long after the issue which brought it into being ceases to exist. It usually finds new issues of interest to its members.

The following points might be examined for any interest group to see if it is functioning well: 1. What is the organizational structure? 2. How is the leadership selected? 3. Where does policy originate? 4. Does policy reflect the viewpoint of the membership, or of the leaders? 5. Does the communication material voice the established policy as expressed by the constitution, by-laws, and other formal statements? 6. Do the activities follow the established policy? 7. Are the available means of communication used? 8. Are pressure techniques used effectively by the leadership and the membership? 9. What are the research and educational methods practiced by the group? 10. Does the group cooperate with other organizations for common ends? While all of these points can be determined to some degree by study of the communication material, only a complete study of the entire organization would be sufficient to answer all points objectively. It is impossible to evaluate all the effects an organization has on society. However, the following factors should be examined in any complete study.

First is the question of how well the organization is educating its members and the public. This can be determined only by direct study of individuals before and after they have been exposed to the educational efforts. As yet there is little evidence that membership does necessarily educate, that there is a change in attitudes and behavior. It is fully possible that members bring with them when they join the attitudes that the organizations would like to feel they have had a hand in forming, and that the major effect of membership is the money provided to enable the organization to act as a pressure group. **It is possible that organizational activities on local levels may be the most important educative process going on in the organization.** This can be determined only by examining these activities at the local level.

Second is the question of the membership itself. Wealth, social position, political and financial connections, and other types of influence of members may be more important factors in our society than mere numbers. This influence of certain members may affect policy of the organization, since these individuals often have more leisure time for participation than the average citizen. This factor can only be determined by a study of these members and the influence they have in the organization and in the public eye.

Third is the question of the paid leadership. Here again only a complete study of personal backgrounds, and a firsthand association with the leaders, can make clear the forces which motivate these individuals to leadership and the policies they advocate. Only by firsthand study of these leaders in action can one determine whether they serve their membership or merely perpetuate their organization and consolidate their own positions.

Fourth is the question of the entire program carried on by the organization. Only a full survey of all activities would be sufficient to show whether all effort was expanded along productive lines. A study of the finances of the organization might help in determining whether the members' dollars were being spent productively and in a balanced program.

Fifth is the question whether the state and local sections of the organization are carrying out the program of the national organization. Here again only a field examination of local conditions will give the information that is necessary.

Sixth is the question of the degree of militancy of the organization in the past and at present in pressuring activities. This can be determined only by a study of past activities of the organization in conjunction with the records or firsthand opinions of the members who did the pressuring and the individuals who were on the receiving end of this activity.

These factors cannot be overlooked in any evaluation of a conservation organization as an interest-group.

Conservation Is Broadly Interpreted

A review of the publications of various conservation groups makes it quite clear that practically every principle of conservation is interpreted with wide latitude, and that every term used, including "conservation" and "natural resources," has many meanings due to differences of social, political, and economic thought. Also evident are certain lines of development of policies and viewpoints. Facts and conclusions added together over the years form a growth or synthesis of thought, which body of thought is a product of the functioning of democratic institutions. The conservation ideas expressed by any one individual or group may be this blended syn-

thesis of years of conservation thought. They might also include concepts rejected by most conservationists years before. They might be a large number, or only a few of the many concepts which have been incorporated into the broad meaning of conservation, but which by themselves are inadequate to solve our resource problems.

Few ideas get lost. If they suit special-interest purposes, they are offered time and time again, to be rejected anew or accepted if the pattern of power has changed. New ideas are not established easily; often acceptance comes too late when conditions for which they were formulated have gone by and still newer ideas are needed.

The differences in policy and action programs of the various conservation organizations may be understood by examining the wide latitude found on a few major points in conservation thought.

1. Many regard natural resources as the renewable resources of forest, range, wildlife, water, and soils. To this concept some add the non-renewable resources of minerals, wilderness, and scenic areas. A smaller group adds the natural forces of wind, tides; the resources of the oceans and the air; and special natural land features such as dam-sites and harbors. A still smaller group regards the entire environment, and man's relation to it, as the scope of the term "conservation of natural resources."

2. In action programs there are those who believe in attacking the problem of any resource by focusing on the single resource, and there are those who feel that the only method of improving our relationship to our resources is by a concerted attack on all resource problems at once—a use of natural, cultural, and human resources at the same time, at both regional and local levels.

3. The concept of the purpose of conservation varies from a belief in the worth of the resource for itself, that other physical and biological forms have as much "right" to exist in this world as man does, to the view that resources are only for man's use, or the needs of the state.

4. Some think that the only concern should be with resources in place; others feel that resources in their cultural use cannot be ignored, even if we call them raw materials.

5. Some think primarily of local uses of resources; others put emphasis on crops or products to be harvested and carried away.

6. Some think primarily of the value of resources as a means to profits obtainable by use; others consider the intangible returns to society as well.

7. Thought on resource-management varies from protection, through restoration, to environmental improvement, with little or no attention to present and potential use.

8. Wise use may refer to efficiency in the economic sense of getting the maximum return at the lowest monetary cost; or it may refer to efficiency in the social sense, getting the greatest return to society for the longest period of time for the largest number of people.

9. The meaning of wise use varies from single resource use, through several uses, to the concepts of multiple use and priority or best use under the changing needs of society.

10. Basic to many conservation conflicts are the varied social, political, and economic viewpoints toward property, ranging from those having the concept of natural right—implying complete freedom to do with property as one pleases—to the concept that property is a privilege granted by society that can be regulated for the good of society as it sees fit.

11. There are conflicting philosophies as to whether government should or should not own natural resources and whether, when it does, the extraction or use of the resource should or should not be a function of government.

12. Some groups feel that resources or property should be used by private owners, and that this use, under the profit incentive, automatically insures the well-being of society. But there are also many who feel that society has not found this automatic insurance of well-being, and the question of which resources, and how many of them, should be controlled by the public segment of our economy, rather than the private segment, has arisen. With the recognition of the need for government to carry out those services which are thought necessary for society, and which the private economy cannot or will not supply, has risen the problem of how far government can go in taking over these functions, or guaranteeing them, before the democratic process is interfered with and the rights of the individual are lost.

13. Finally, there are those who feel that regulation and law, aids and subsidies, and other factors such as self-interest, are sufficient to solve our resource problems; and there are those who say that these are not enough, that a conservation ethic is also required—a new social viewpoint toward resources whose value measure is not the dollar alone, but which includes also the welfare of mankind.

Conservation Publications Have Important Role

Conservation organizations are interest-groups formed for the purpose of bringing about the conservation of natural resources. It seems to me, after studying the publications of several conservation organizations, that, as educative forces, they can make effective use of their means of communication if they take cognizance of sev-

eral points.

They should consistently voice policy. They should indicate the needs and the most effective methods for pressure activity. They should also indicate the needs and the most effective methods for educating their membership and the public in conservation matters.

Although conservation organizations vary widely in breadth of interest, even those with a major interest in one aspect of the entire resource field cannot afford to ignore the interdependence of all resources in the environment and the economic, social, and political implications of resource-use problems. It seems to me that in order to be effective in its own smaller sphere of interest a conservation organization has to educate for an understanding of the entire resource field. It must educate for an understanding of the ecological viewpoint which includes the dynamics of interaction and interdependence without which a comprehensive understanding of man's relationship to the environment is not possible. As Paul Sears said in "Deserts on the March,"

> **"All renewable natural resources are linked into a common pattern of relationship. We can save any one of them only by measures which save them all. And we are a part of the whole which must be conserved."**

The educative process, in this frame of reference, should seek to develop a comprehension of the necessity for working in accord with ecological principles in resource use and land management. This should include an understanding of biotic balance, of the interdependence, interrelations, and interactions between resources, between resources and man, and between man and his cultural as well as physical environment. It should also include the concept of ecological succession, which results from these relationships. As a result of such an approach one is led to the idea of land-use capabilities—that there is a best use or combination of uses for each type of land, each according to its potential, long-term productivity with reference to man's needs—and to an understanding of the necessity for comprehensive, integrated, resource planning.

Many of the social values deriving from man's manipulation and use of the environment cannot be measured adequately in monetary terms. Furthermore, new values arise as the needs of society change, and the use to which any part of the environment may be put should be determined by the needs of society, not by the short-term individual profit which may be derived from it. Our economic system is based on the premise that the individual is entitled to profit from the use and development of resources and property, but increasingly with the qualification that society as well as the individual benefits. There are, therefore, appropriate to the educative programs of conservation organizations certain concepts that are not subject to a simple monetary evaluation. Among these are the concepts of multiple use, priority of use, and of trusteeship. The concept of multiple use is that any resource or part of the environment can be used so that more than one value, in crop or service, can be realized at the same time. The concept of priority of use is that for any resource or part of the environment there are many uses, but that at any particular time and place, depending on the needs of society, one or another crop or service may have a greater social value. The concept of trusteeship, or the obligation of ownership, is that property or resources must be used with full consideration for social values involved.

Far-Reaching Responsibilities

In our society the private use of resources is determined largely by economic forces and the profit incentive, but there are many uses of resources which are necessary to society for which there are inadequate profit incentives. Society must supply these incentives through government or see to it, by aid or regulation, that the private economy encompasses these values. It would seem, therefore, that conservation organizations should stress those uses of resources which the private segment of the economy cannot or will not supply—they must stress the providential functions of government.

Conservation organizations, as interest-groups, cannot ignore the social, political, and economic framework in which resources are used—in short, they cannot ignore the culture of which they are a part. It would seem that their educative program should include the provision of information to their membership and the public on several matters. They should provide information as to the nature of natural resources and the materials and services that society gets from the physical environment. There should be provided an analysis of resource problems. This would include information about the existing resource policies of the different branches and levels of government which are sometimes in contrast to policies that seem desirable in the light of scientific knowledge and conservation ethics, and also information on administration, management, and current planning of resource use at all levels. There should be information on legislative and judicial action with respect to resources. There should be evaluation of all these matters and, where indicated, criticism of legislation, administration, management, and planning at all levels.

Finally, conservation organizations should seek to develop a comprehensive philosophy of conservation in harmony with the ethical considerations toward which we work in a democratic society.

Soil Management, Soil Sense and Soil Conservation

C. L. W. SWANSON

The American public has been frightened by the grim predictions of world food shortages by alarmists concerned with the land and its care. In the long run this is bad psychology. Statements are not enough. We need some straight thinking. Saving soil won't solve all the world's food ills. It will help tremendously, but it is more a complicated political-economic-sociological problem.

C. L. W. Swanson, a Member of the Soil Conservation Society of America, is Chief Soil Scientist for The Connecticut Agricultural Experiment Station, New Haven, Connecticut. Dr. Swanson presented this paper at the opening session of the 1950 Annual Meeting of the Southern New England Chapter, Soil Conservation Society of America.

SOMETIMES I THINK conservation has been presented as a negative thing. For example, if you don't do this or that, some say, it won't be long before we will all die from lack of food. Why not present it more positively—as a way of life? The practice of conservation will mean a fuller life for *us*—for our posterity, too—but for us *right now*. Isn't it rather esoteric to think and speak gloriously of our posterity when we have the mean business of living with us *now?* If we do a good job of managing our land, we will prosper, and axiomatically, it will redound to the benefit of our descendants.

There is nothing like free discussion of a subject—although I will admit it sometimes get pretty hot. But that is a right and a heritage we have in these United States and I hope we will exercise it vigorously today.

Need Conservation Practices Adapted to Southern New England

I'd like to inject a thought about conservation practices for Southern New England, just to get the ball rolling. I thing we in Connecticut, Massachusetts, and Rhode Island are a bunch of copy cats. We've been trying to apply conservation practices here that are not all adapted to our area. Our States, rightly or wrongly, were among the last to adopt the idea of good soil management for soil conservation. Many of us thought we didn't need it. We were so engrossed about other things we didn't think about conservation.

But when we finally saw the light, during the interim we hadn't been doing much in the way of thinking what should be done in the way of conservation practices. So we did like all of us do—we followed the line of least resistance. We borrowed conservation practices from the South and the Midwest and tried to apply them here.

For example, terraces by and large won't work on our short choppy slopes. But we advocated them. We've got the big field complex, too. Clearing stone walls to make bigger fields. I wonder if there actually might be less erosion in little fields. (I am not considering the machinery and the economic aspects here.) Why can't we find some way of stopping erosion on our potato areas. It is always necessary to rotate, have land in sod crops to control erosion? I wonder. Maybe we could use some kind of a chemical to hold the soil from eroding which would also act like organic matter. Fantastic? So was hybrid corn and soil testing before they were "thunk up."

We've imported the techniques for mapping erosion, too. We talk in such terms as 0 to 25 per cent of the top soil gone or 75 to 100 per cent of it eroded away. Actually, under natural conditions, the top soil on well drained rolling landscapes in New England was only about three inches thick. Anyone who has looked at our soils in forested areas knows this. And yet we talk about top soil here as though it were 12 to 18 inches thick like it is in Iowa.

What we really mean instead of the top soil is the plow layer. In this area with thin A horizons on plowing they are incorporated with the upper part of the B horizon. So we really are farming "made" soils, at least "made" soils in comparison with those in the Middlewest. The Middlewestern soils have "built-in" fertility; here we "build in" the fertility. We have two different kinds of land management for these different kinds of soils.

But, as stated before, the productivity of these soils has been greatly improved mainly by large applications of commercial fertilizers used in intensive farming as practiced in southern New England. Here, we may not

The title of Dr. Swanson's article is intriguing. Often we find persons among us who sometimes forget the practical side of the conservation movement. It is this group whom Dr. Swanson had in mind when he added "Soil Sense" to the title. The experts in science and the applicators of soil conservation, he points out, need to get together to argue and discuss their points of view. If this is done there will be no forgetting of the pracical problm of getting the conservation job done.—EDITOR.

need to be so concerned about whether we are losing the "topsoil" because we never had much anyway. More, we should be concerned about the fertility that we are losing because of erosion.

So I think we can add another kind of erosion to the usual sheet, rill and gully erosion—and that is fertility erosion. With as much as a ton or more of fertilizers added on vegetable, tobacco and potato fields, on sloping land it is safe to say that some of the added fertilizer is washed down the hill in solution or is carried bodily away as part of the soil. Anyone who has noticed the greener grass at the foot of intensively cultivated fields knows that this isn't due to the natural fertility of the soil washed down the slope. Soils in this area are naturally infertile. The increased grass growth is due to the fertilizers eroded down the slope. So maybe we ought to be more concerned about fertility erosion than soil erosion; but the two go hand-in-hand.

We can't afford to waste fertilizers, and especially when we have the know-how and it is relatively easy to keep them on the land. Fertilizers are a natural resource, too, and in using them wisely we are conserving another natural resource.

But I shouldn't leave the false impression that we don't have any good conservation pratcices in effect in Southern New England. Lots of good conservation is being used here, and lots more will be soon, but there is always room for improvement.

Farm Land at its Correct Speed

We've got to use our land at its correct speed. All land cannot be farmed at the same speed. I don't think we have found out what that speed is for our soils. For example, some people say that our soils here are now in poor condition. In fact, in our potato, tobacco, and vegetable areas our soils have more fertility in them than they ever had. But even so, some of them are washing down to the Atlantic. This land is out of step, in one sense, and if conservation were applied, production would be still greater.

We must be concerned about our soil, and the best way to understand it is to study it. Soils are adapted for various crops. Professor Johnson, the father of agricultural experiment stations in America and the founder of this Station, first noticed that tobacco did well on the sandy soils of the Connecticut Valley and was responsible for establishing the shade-grown tobacco farming in that area. The Indians, I am told, told the Pilgrims that cranberries grew well on wet sandy areas. Now we have the cranberry bogs near Plymouth, Massachusetts. It isn't always technical knowledge that is limiting—it is keen observation (plus initiative) whether it be in the laboratory or in the field of application—that pays off.

To make real advances in conservation we need to carry on research. We need to make a "business of discovery for the benefit of farming" as Professor Johnson of this Station put it more than 75 years ago. This research needs to be independent—and we need the kind where there is no apparent objectives in view—just curiosity . . . in other words, basic research. The States of Connecticut, Massachusetts, and Rhode Island long have been leaders in this.

We need only to mention names like Wheeler of Rhode Island, Haskell of Massachusetts, and Johnson of Connecticut to bring to mind some of the very early work in soils. Their names may not be as fresh as men now living but their early work was just as important.

The First Conservationist in America

To go back still further in history, we find that only about 20 miles from here we had a man by the name of Jared Eliot who can be credited as being the first man in America to give serious thought to conservation.

He called attention to soil washing and its dangers while they were still undreamed of by most American farmers. Eliot was a minister and a physician in Killingworth, a little town east of New Haven. During his calls he noticed the way farmers farmed. He noticed that water running from a bare hillside was muddy. He believed that the mud in the water was fertile soil from above; every time water ran off of bare fields, the fields got poorer. In 1747 he published a book on his observations and findings. This was the first book on agriculture published in America and constitutes the beginning of the literature on agriculture in general and on erosion control in particular.

Now to make reference to only one research find as it relates to conservation. The discovery of how to produce hybrid corn by Dr. D. F. Jones of this Station has had tremendous implications on soil conservation. With an estimated increase in yield of 20 per cent for the United States due to the use of hybird corn, more could be produced on fewer acres and the poorer land retired to grass and tree crops, and more of the row crop land rotated with grass and legumes. Soil erosion would be better controlled and fertility of the land increased. It has been estimated that over 12 million additional acres of open-pollinated varieties would have been needed to produce as much corn as the 67 million acres planted to hybrid corn in 1949. Dr. Jones hasn't been thought of usually as a conservationist, but he certainly is one of the first rank.

What we need now is another discovery that will take out of production 12 million or more acres of eroding land and still produce more on the remaining acres. Would a chemical soil structure fixer be out of place?

Problems of Drainage in a Soil and Water Conservation Program

PAUL J. ZWERMAN

The concept of Soil and Water Conservation has various meanings. Different people see the problem in light of their past experiences. An agricultural economist visualizes problems in farm mangement or land management. Engineers regard soil and water management largly as a matter of constructing terraces or ditches. A farmer frequently speaks of building up his land by the use of conservation measures.

PROBLEMS OF LAND drainage cannot be separated from the general problems of conservation. The agriculture of some of our most productive land in the United States is dependent upon proper drainage. Although the practice of drainage land, is old, the science is, like soil and water conservation, relatively new.

As a farm practice, lands in Europe have been drained for several hundred years (2). In the United States tile drains were first installed by John Johnston near Geneva New York in 1835. After the civil war the invention of the dredge, to dig large outlet ditches, (3) caused a rapid development of land drainage in the United States. The present distribution of intensively drained land very closely approximates that distribution given in the 1930 census. (1) (Figure 1.)

The distribution of these intensively drained areas is not due to chance. The determining factors are: climate, topographic position, soil type, crops adapted to the area, type of farming, and soil structure management.

Ordinarily we think of drainage as a means of removing excess water. The more arid portions of the United States should not need drainage. However, figure 1 shows a considerable amount of drainage in the dry area of the West. Excessive irrigation water frequently evaporates and carries high salt concentrations upward in the soil to areas within the root zones of salt-sensitive crop plants. In such locations tile drains are placed to a depth of six or more feet in gravel envelopes. The soil to this depth is then leached of excessive salts. Here we are again forced to recognize the importance of climate in the functioning of a drainage system.

Topographic position together with soil type are very likely the determining factors in the distribution of drained land in the Southeastern United States. High value cash crops are produced both in the South and West. Both types of farming are likely to be large scale operations. Open ditch drainage is widely used in the production of sugar cane on flood plains and muck soils.

Our most intensively drained area is found in the Corn Belt. Under relatively uniform conditions of climate, topography, soil type, crops produced, and type of farming, the factor of soil structure management takes on special importance in the consideration of drainage. The land in Northwestern Ohio is representative of the general conditoins found in the Corn Belt. The Ohio Agricultural Experiment Station has recently established a comprehensive field study at Tiffin, Ohio. This investigation is one of the largest in the United States. The experiment has just been started. It represents a very stimulating approach to the problem of soil structure management and its relation to land drainage of a representative corn belt soil with flat topography.

The experimental working hypothesis behind this study is that conservation farming of corn belt soils may lead to an economical and permanent solution of most drainage difficulties. Drainage experiments are difficult to design because they cannot be confined to small plots. Every drainage operation is a field scale operation.

The Tiffin, Ohio experiment has taken advantage of this situation. (Figure 2.) Six fields of approximately eight acres each were selected. In each field tile drains were installed at uniform grades and depths with adequate buffer lines to give uniform experimental condi-

Figure 1. Black areas represent the land in drainage enterprises on the basis of the 1930 census.

Paul J. Zwerman, a member of the SCSA, is Associate Professor of Soil Conservation, Cornell University, Ithaca, New York. Mr. Zwerman presented this paper at the 1950 Annual Meeting of the Southern New England Chapter, Soil Conservation Society of America held in New Haven, Connecticut.

Figure 2. Foreground shows a general aerial view of the Ohio Agricultural Experiment Station, Tile Drainage Research Fields at Tiffin, Ohio.

tions. The soil management practices used were those of soil depletion versus soil conservation.

Two of the fields are subject to adequate fertilizer application with removal of crop residues. The crop rotation is a soil depleting one of corn and small grain without cover crops, legumes or manure. The four remaining large fields are managed in a rotation of corn, small grain, two years of alfalfa grass sod with return of crop residues in the form of barnyard manure together with adequate fertilization.

Tile drains were spaced in all six fields at distances of thirty and sixty feet apart. Depths on each spacing were twenty four and thirty six inches to the bottom of the tile. These depths and spacings were selected in as much as they represented the reasonable extremes on either side of the prevailing recommended practice of fifty-foot spacing with an average depth of two and one-half feet. One half acre undrained fields were established with soil management practices identical to those of the larger tile drained fields.

Water running out of the tile lines for the varying systems of management will be measured. A study of plant growth and yield with respect to intensity of tile drainage is planned. Necessary meterological data are being collected.

From a philosophical view point, land drainage is an attempt to modify the effect of a complex series of climatic events in such a manner that a more desirable situation develops for growing crop plants. This point of view cannot be over emphasized. Under the influence of any one particular favorable season a field that would normally need to be drained will produce a bumper crop. Under a different highly adverse season a well drained, well managed field may produce only a poor crop. All of the talents of the conservationist together with the arts of the experienced farmer must be applied if a maximum crop yield is to be obtained from any given field year after year.

It is interesting to follow through the seasonal sequence of events on a typical corn belt farm. If one disregards the question of soil fertility and liming—which are assumed to be adequate—the quantity of sod turned under, the time of plowing, the number and kind of fitting operations, the date of planting, and the number of cultivations are all largely determined by conditions of soil structure management and level of drainage. At the end of the growing season the harvest operation itself is frequently controlled by the conditions of drainage present in the field.

If the field is wet over the winter, legumes and grasses are likely to heave badly. The sod to be turned under for the corn crop is likely to be a very thin one. It will be much more difficult to plow this sod in the spring than it would be to plow a sod with a well developed mat of roots. These roots would serve as a support for the farm tractor and lessen soil compaction. Because of the poor sod associated with the wet field, this field is likely to be plowed in the fall with subsequent further soil structure break down. It is also likely to be plowed late in the spring—too late for a good crop of corn.

Difficulties do not end with late plowing. Because of the poor sod and generally wet condition, the plowed field is likely to be cloddy. So cloddy that the hot sun and winds of early summer will rapidly dry the surface soil. Surface moisture falls to such a low level that kernels of corn planted in the top two inches of soil will not germinate until the necessary moisture is supplied by rain. The hazard of producing the crop has been multiplied before the corn sprouts.

If the farmer is not content to plant corn in a cloddy field, he has to reduce the clods to fine powder and then proceed with his planting operations. This pulverized seed bed is again hazardous because rain is likely to seal the surface soil with subsequent serious crusting. Water movement to under drains is likely to be delayed by this surface crust. The bad mechanical effects of crusting are minor as compared to the bad effects of poor aeration and lowered temperature of the surface soil. Young corn plants under a hot sun with water standing around the root system have been seen to yellow in twenty four hours.

In such a wet field, cultivation will be difficult if not impossible. Weeds are very likely to compete successfully with the growing corn crop. Even if weeds do not compete for moisture and plant nutrients, a stunted root system will very likely be unable to supply the growing plant with water from the subsoil as the season advances. This has led to the parodoxical statement that certain

(*Continued on page* 199)

Conservation Effects of Crop Rotation on a Sandy Soil in Vegetable Production

O. R. NEAL AND G. D. BRILL

Continuous cultivation of New Jersey Coastal Plain soils in vegetable production has led to deterioration of soil structural properties and, despite higher fertilization, to a decline in yield of various vegetable crops. The decline in structure has been evidenced by crust formation, increased runoff and erosion, impairment of drainage, and shortages of soil moisture. Maintenance of favorable soil physical conditions appears essential for both conservation and for maintenance of crop yields. Systematic rotation of cultivated crops with grass-legume mixtures is a practical method of improving soil physical properties. A sandy Coastal Plain soil under rotation management has shown consistently reduced runoff and erosion and increased crop yields as compared with continuous cultivation. Such rotation management appears an essential part of the conservation program for these soils.

THE PRACTICE OF CROP ROTATION is very old. In numerous sections of this country crop rotations, involving some regular sequence of cultivated and non-cultivated crops, have been followed for many years. It is commonly recognized that such cropping practices aid in soil organic matter maintenance, weed and disease control, and improve soil productivity. More recently it has become evident that such practices improve physical conditions of the soil thus providing better aeration and drainage and reducing runoff and erosion losses. In general, however, the above factors have been only incidental in determining whether or not a good crop rotation would be followed. Economic need has been the primary consideration. In general farming areas and on dairy and other specialized livestock farms there is commonly a need for both the grain and forage crops produced in a rotation. In these enterprises cultivated crops are commonly grown in regular rotation with small grains and grass-legume mixtures.

On the vegetable and truck crop producing areas of the Coastal Plain in New Jersey and adjoining areas, little or no livestock is kept on many of the farms. The replacement of horses, as a source of farm power, by tractors and trucks has removed all need for grass and legume crops as animal feed on these areas. In this situation the decision as to whether or not cultivated crops will be rotated with sod crops rests on effects of such rotation on soil and water conservation, physical soil condition, and on soil productivity. Many Coastal Plain areas have been cultivated continuously during recent years in the production of vegetable crops. Despite heavier fertilization and generally improved cultural practices, soil productivity has declined under this management in many cases (3).

This report deals with the effects of crop rotation on soil and water losses and crop production from a sandy Coastal Plain soil.

O. R. Neal is Project Supervisor in charge of research for the Soil Conservation Service in New Jersey. His headquarters are at New Brunswick, New Jersey. G. A. Brill, Soil Conservationist, is in charge of the Soil Conservation Experiment Station at Marlboro, New Jersey.

Method of Approach

This work is a part of the conservation research conducted cooperatively by the Soil Conservation Service Research Division and the New Jersey Agricultural Experiment Station. Field studies were carried out on plots at the Marlboro Soil Conservation Experiment Station. The soil is a loamy sand now classified in the Freehold series. The land slope is three per cent. The area is similar to much of the Coastal Plain soil used in vegetable production in New Jersey and adjoining areas.

Four rotations are included in this study. Each of these follows a three-year cycle with characteristics as follow:

Rotation I	Tomatoes, sweet corn, and peas followed by snap beans.
Rotation II	Tomatoes, sweet corn, and grass-legume sod.
Rotation III	Tomatoes followed by 10 T./A. compost and rye winter cover, sweet corn followed by ryegrass and vetch cover, and peas followed by ryegrass and vetch cover.
Rotation IV	Tomatoes followed by 10 T./A. compost and rye cover, sweet corn, and grass-legume sod.

Figure 1. Rotation plots and runoff measuring equipment at the Marlboro Soil Conservation Experiment Station.

The grass-legume seeding in Rotations II and IV is made without a nurse crop in the fall following sweet corn harvest. The mixture includes alfalfa; red, alsike, and crimson clover; and timothy. One cutting of hay is removed and all additional growth is left to be plowed under.

Beginning in 1942, the four rotations have been operated on 48 plot areas of which only 24 have runoff measuring equipment. Since two years are required to bring a 3-year rotation into full crop and treatment sequence, results are reported for the 6-year period 1944 through 1949.

It has been reported previously (8) that the 48 plot areas involved were used in another cover crop and manure study from 1938 through 1941. The present rotations are distributed symmetrically over these previous treatments. Thus each crop of the rotations appears each year on each of the previous treatments. During the first years of the rotation study the previous treatments exerted some residual effect on runoff, soil loss, and crop yields. During the 1944 to 1949 period, however, there is no significant residual effect on either yields or conservation wherever the design of the experiment permits a comparison. Accordingly, conservation effects and crop yields from the different rotations are compared directly with each other.

The plot size is 14 by 70 feet. Runoff plots are inclosed by steel borders and have a concentrating trough connected to a steel silt box. An aliquot of the overflow from the silt box is caught in a second tank by means of a multiple slot divisor.

The cultivated crops in all rotations are fertilized uniformly in accordance with local recommendations. In order to balance the total fertilizer application in the different rotations, the sod mixture in Rotations II and IV receives the same fertilization as the peas in Rotations I and III.

Conservation Effects of Crop Rotation

Average soil and water losses from areas in each of the rotations are shown in Table 1.

Table 1. Average soil and water losses under four rotations during a 6-year period.

Rotation No.	Soil loss	Water loss[1]
	Lbs./A.	Sur. In.
	Average annual losses	
I	5130	5.53
II	2200	2.47
III	2780	2.69
IV	1600	1.81
	Average growing season[2] losses	
I	4580	3.55
II	2090	1.71
III	2770	2.02
IV	1540	1.10
	Average winter season losses	
I	550	1.98
II	110	.76
III	10	.67
IV	60	.71

[1]Average annual precipitation 45.81 inches.
Average growing season rainfall 28.93 inches.
[2]Includes 7-month period from April 1 through October 31.

Any of the rotations which include sod or regular winter cover have shown soil and water losses much lower than those from Rotation I. Rotation IV, which includes a year of sod, a compost application, and cover each winter, has brought about the greatest reduction in soil and water losses.

The effectiveness of Rotation III in reducing soil and water losses should be interpreted with some caution as compared with ordinary farm practices for winter cover crops. In this rotation the ryegrass-vetch seeding following peas is made in July. The mixture ordinarily makes a vigorous growth during the late summer and fall and occupies the land for a period of about nine months. The ryegrass-vetch seeding following corn is made in late August and occupies the land for about seven months. A compost application follows tomatoes and a rye cover is on the land for about six months. Thus, Rotation III, while including a cultivated crop each year, is actually out of close-growing vegetative cover for only about 13 to 14 months during each 3-year cycle. This cropping system cannot be directly likened to one where long-season cultivated crops appear each year with comparatively late seeding and early plowing of winter cover crops.

The seasonal nature of erosion losses is emphasized by comparison of the average growing season losses with those during winter periods. This relationship has been pointed out in various areas (1, 4, 6) and has been previously reported at this location (2). In this case soil losses during the winter period have been extremely low regardless of the soil management and rotation system followed. Water losses vary in the same direction but to a lesser extent.

Evaluation of effects of the different rotations on soil properties which influence runoff and erosion can best be made by comparing losses under sweet corn and tomatoes. These crops appear in each of the rotations. Average soil and water losses under these crops during growing seasons are shown in Table 2.

Table 2. Average growing season losses of soil and water under tomatoes and sweet corn in different rotations.

Rotation No.	Tomatoes		Sweet Corn	
	Soil loss	Water loss	Soil loss	Water loss
	Lbs./A.	Inches	Lbs./A.	Inches
I	4540	3.43	5160	4.15
II	2250	1.59	3770	2.77
III	2570	1.53	2810	2.07
IV	1800	1.05	2480	1.80
Least significant difference — Water loss			0.48	
Soil loss			934	

In considering the data in Table 2 it should be kept in mind that these losses occurred during growing periods. Direct effect of sod and cover crops on runoff is not included in these averages. All areas were plowed and cultivated in the same manner during the period of these measurements. It is evident that widely different amounts of soil and water loss occurred from areas under the different rotations. Losses from areas in Rotation IV, for example, are considerably less than half those from areas in Rotation I during the same periods of time. In general, Rotations II, III, and IV are more or less alike in conservation effectiveness and all are much superior to Rotation I. The relative soil loss from the two crops under Rotation II is of interest. Tomatoes follow directly after the grass-legume sod crop, and sweet corn occurs during the second year of cultivation after sod. There is no winter cover between these crops. Soil loss from tomatoes in Rotation II is lower than in Rotation III but the order is reversed during the following sweet corn crop. It appears that the compost treatment and cover crop in Rotation III preceding sweet corn has considerable effectiveness. This emphasizes a point that has been frequently observed to the effect that frequency of application of organic matter to the soil is an important factor in conservation. It appears that the conservation effectiveness of Rotation IV results from the fact that the substantial addition of organic matter to be expected from the sod crop is supplemented by compost and a winter cover during the following winter period.

In evaluating the effects of the rotations on soil and water losses, as shown in Table 2, no attempt is made to separate direct effects due to improved soil physical conditions from indirect effects due to improved soil productivity. The latter is often an important factor in conservation. Improvement of soil structure, induced by the rotations, ordinarily stimulates crop growth as will be shown later. The increased density of vegetation, in turn, provides better protection for the soil surface and thus reduces soil and water losses.

Effects of Conservation Rotations on Crop Yields

Details of the effects of conservation rotations on crop yields in this and other studies will be shown in a later report. Yield data from this study have shown that the rotations and soil management systems most effective in reducing soil and water losses are also most effective in increasing yields of cultivated crops. This general effect would be expected. It has been shown (5, 9, 11) that rotations and cover crops improve physical conditions of the soil. Other reports (10, 12) have shown the relationship of certain physical soil conditions

Figure 2. *Left*—Sweet corn under Rotation 1 treatment. *Right*—Sweet corn in Rotation 4. Baskets indicate 1950 plot yields.

to both runoff and erosion and to crop yields. It seems reasonable to expect that improved aggregation and porosity of the soil would permit more rapid entrance of water at the surface and more rapid percolation to lower depths of the soil profile, thus reducing runoff. These same conditions should provide better soil aeration and hence more favorable conditions for plant growth.

Average annual yields of tomatoes and sweet corn from the four rotations included in this study are shown in Table 3.

Table 3. Average yields of tomatoes and sweet corn under four crop rotations, 1944-1949.

Rotation No.	Tomatoes	Sweet corn
	T./A.	#1 ears/A.
I	12.98	9090
II	15.34	10010
III	13.84	11830
IV	16.10	11970
Least significant difference — Tomatoes	1.14	
Sweet corn	682	

Fertilizer applications are in accordance with local recommendations and have been identical in each of these rotations throughout the period of operation. Average yields during this period of two rotational cycles have varied inversely with soil losses in the different rotations. It appears, as suggested above, that soil conditions which are favorable for conservation are also favorable for improved crop growth and yield.

Data on differences in physical conditions of this and other soils under different conservation rotations will be reported later. The relationship of some physical soil properties to soil and water conservation has been shown (7, 13). Mechanical conservation practices, such as contour cultivation and terracing, owe part of their effectiveness to the fact that surface water is held on the field for a longer period of time. The extent of water absorption, and hence reduction in runoff, that occurs during this time will necessarily depend on the rate at which water can enter and move through the soil layer. Crop and soil management systems which increase the rate and amount of water absorption by the soil will thus increase the effectiveness of mechanical conservation measures. At the same time, the improved soil conditions brought about by the conservation systems of soil management result directly in increased efficiency of crop production.

Summary

Little or no livestock is kept on many vegetable and truck farms of the Coastal Plain in New Jersey and surrounding areas. In the absence of need for pasture and hay crops, the rotation of cultivated crops with grass-legume mixtures is not commonly practiced. Many soil areas have been cultivated continuously and intensively during recent years. Under this management numerous cases of deterioration of soil physical conditions, increased runoff and erosion, and decreased crop yield have resulted.

Maintenance of favorable physical conditions of the soil appears essential for effective water and soil conservation. Regular rotation of cultivated crops with sod mixtures is a practical and effective method for maintaining desirable physical properties of the soil.

Average soil and water losses have been much lower from cultivated areas rotated with clover-grass sod than from continuously cultivated areas. During growing seasons while cultivation operations were identical on all areas, soil and water losses were 55 and 62 per cent lower, respectively, from the most effective rotation as compared with continuous cultivation.

Crop yields were improved under these conservation cropping systems. The largest yield increases came from the cropping systems that were most effective in conserving soil and water.

Intensive cover cropping practices were effective in reducing soil and water losses and in increasing soil productivity.

Crop rotation, as practiced in this study, reduces the intensity of cultivation and provides regular additions of organic matter to the soil in substantial amounts. It is suggested that some measure of crop rotation is an essential part of an effective conservation

(Continued on page 199)

Photo by Alfredo Rivas Larralde

Conservation practices are emphasized in this garden at the Forest Rangers' School near Caracas, Venezuela. The school offers a two-year course to young men interested in protecting the country's forests, and who will be helpful to farmers. The first year is devoted to a number of basic studies and silviculture, plant propagation, soils and fertilizers. The second year includes topography, rival legislation, forestry, soil conservation, agricultural practices and general administration.—*Annette L. Flugger, Technical Assistant, Pan American Union.*

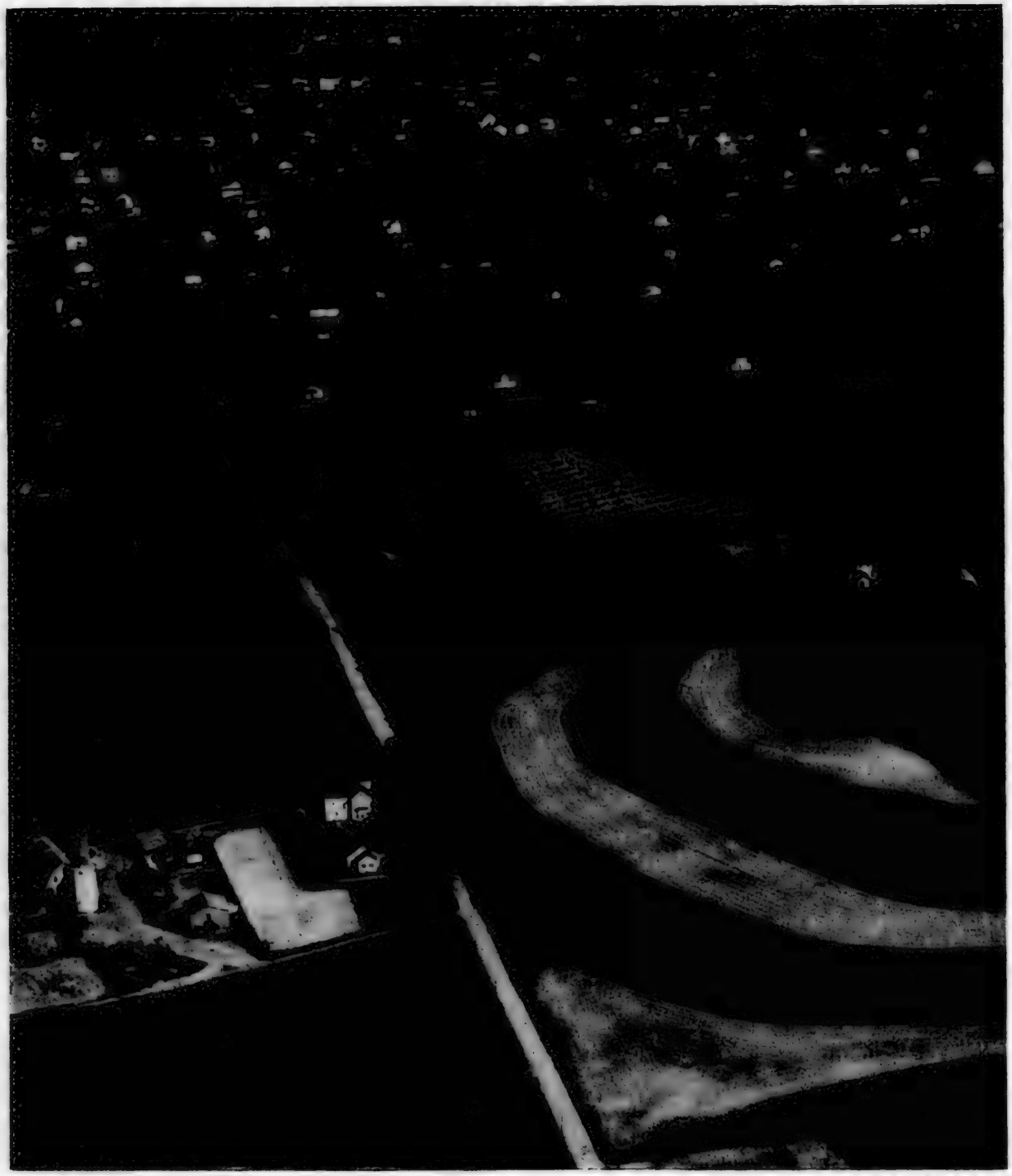

Photo by Gordon S. Smith

Appropriate soil and water conservation measures are beneficial to urban areas, industry and agriculture. It is important that this relationship be understood and strengthened.

Photo by Hermann Postlethwaite

Hereford cattle grazing on white Dutch clover and Dallas grass on the Selden Sheffield farm near Greensboro, Alabama. This land was at one time used for row crops.

Soil Conservation Service Photo

This is native bluestem grass that covered the prairie sections of Missouri and adjoining areas when settled by white men.

Factors Affecting Rate of Water Intake In Texas Blacklands

WILLIAM R. ELDER

The key factors of yield are water and fertility, Mr. Elder points out in this article. Where fertility is adequate the supply of moisture determines yield. Physical characteristics of soils change, as a result of cultivation, reducing both the intake of water and total amount of available water stored. Compacted layers or plow pans further reduce moisture for crop growth by causing shallow root systems. Soil structure can be materially improved by the use of deep-rooted legumes or grasses. Deeper rooted crops, more rapid intake and greater moisture storage result.

THE BLACKLANDS occupies some 12 million Texas acres, an area roughly 2½ times as large as New Jersey . . . or nearly 18 times as big as Rhode Island.

The Blacklands, shaped like an inverted boot, has its sole along the Red River and stretches south until its top is lost in the Coastal Plain of the Gulf.

Lying between the humid, forested soils of East Texas and the dryer range lands of West Texas, the Blacklands is an area of heavy clay and clay loam soils unique in their physical and chemical characteristics.

It's a big territory with big problems. Because Blackland soils are particularly adapted to growing cotton, a single row crop system has persisted throughout the 60 to 80 years these lands have been cultivated. *Continued cropping to cotton has brought trouble to the Blacklands in the form of declining yields, severe sheet and gully erosion, and widespread losses by cotton root rot.* These are among the key problems the Blackland farmer faces.

In attempting to find remedies for the ills of this area, the limiting factors for yield must be clearly defined. Aside from damage by insects or disease, either a shortage of moisture or a shortage of fertility is the limiting factor on yield of cotton or any other crop.

Fertility does not appear to be the major cause of declining yields. Blacklands long have had a reputation of not responding to fertilization. Countless studies have shown that fertilizer-prompted yield increases, where found, have not been economically sound. Only recently, where legumes and grasses have been introduced into farming, have fertilizers paid their way. Phosphates under legumes and nitrogen for grass are being used more and more.

Proof that over-all fertility is not the primary limiting factor is shown every year during which a well distributed summer rainfall occurs. In these years, fields that have not yielded over one-third bale of cotton an acre for over ten years will suddenly yield half bale or more. Had fertility really been the limiting factor, no amount of rain could have increased the yield to that extent.

In evaluating productivity factors on these soils it is important to remember that we are dealing with land which has been farmed 60 to 80 years with few soil-improving or soil-conserving practices, such as rotations, cover crops or additions of manure. The physical characteristics of the soil have changed to such an extent that it is hard to believe these were once the same soils now found across the fence in a heavily used but yet unplowed native meadow.

In the deep, fine-textured slowly permeable soils (Houston series), which comprise 80 per cent of the Blackland, we find that cotton yields have decreased 30 per cent in 55 years, or about 0.5 per cent annually. Organic matter has decreased 60 per cent in 60 years and the large buckshot-sized aggregates needed to keep these heavy soils open to water and air have decreased 46 per cent in 50 years, or 0.9 per cent annually.

Soil Moisture in Short Supply

Since fertility does not appear to be the limiting factor in yields, then it must follow that moisture is in short supply. In appraising the moisture supply, two points are significant: how fast water can enter the soil, and how much water the soil can hold. Intake rate studies using concentric rings have revealed highly significant differences in rates at which the soil can take water. As anticipated, differences were revealed for intake rates on soils with varying permeabilities and textures. An unexpected finding was a wide variation of intake rate within a single soil, depending on the treatment the soil had received. Shallow-rooted legumes like vetch and peas gave the smallest increase in intake rates over continuous row crops, while deep-rooted clovers and grasses gave consistently higher intake rates. The following table gives the average values for the three main soils of the Blacklands.

When factors affecting rate of water intake are examined, these results are not so surprising, considering

William R. Elder, a soils survey supervisor attached to the Western Gulf regional offices of the Soil Conservation Service in Fort Worth, has spent 12 years working on soils problems in the Blacklands of Texas.

Figure 1. The chunk of earth on this shovel has a hard-as-bricks plow pan (shown vertically here because shovel is lying on the ground) for its center. Built up by cultivation to the same depth year after year, it's a key bottleneck to satisfactory water intake. Note that no roots have penetrated below plow pan. Use of deep-rooted legumes in rotation with cotton and other cash crops will help eliminate plow pans, facilitate moisture penetration and storage.

that these soils average 40 per cent clay content. Cover on the land is conducive to rapid water intake and these soils have been notably lacking in cover at critical times because of a long-continued custom of bedding the land in the fall and leaving it bare until planting time in the spring.

Surface tilth is another factor which affects intake, and crusted conditions are often found especially on the acid, very slowly permeable soils along the eastern border of the Blacklands. On the major portion of the Blackland, however, surface tilth or structure is much the same as the structure of the rest of the soil because of the deep cracking which occurs each summer during dry periods.

Cracks to depths of ten feet are common followed by rapid swelling and heaving when wet weather comes. Water stable aggregate studies show almost the same proportion of sizes at 36-inch depths as occur at the surface. However, the main bottleneck to water intake is the widespread presence of "plow plans" built up by cultivation to the same depth year after year. Intake tests taken above and below this plow plan show its drastic effect on water intake. On a field of very slowly permeable, heavy clay subsoil, for example, the intake rate was 0.29 inches an hour above the pan. Removal of the pan, however, with the concentric rings set in the subsoil increased the intake rate to 0.56 inches an hour. Heavy subsoils have received much of the blame for slow water intake in the Blackland, but close scrutiny always shows that the bottleneck is either in surface crusting or in a man-made plow pan.

Deep-rooted Grasses Increase Intake

Intake tests on soils which have grown deep-rooted clovers reveal the real possibilities of catching and storing rainfall. Rates on lands so treated which are in good physical condition run as high as eight inches an hour, and are exceeded only by the native meadows which are still in deep-rooted prairie grasses. Certainly the results given in the intake table indicate improvement in the rate at which water can be absorbed. Yet these results are but the beginning since one year of legumes does not restore the water absorbing ability to more than a fraction of its potential rate.

Stopping up the supply pipe that gets water into the soil is bad enough, but there is increasing evidence that the same practices which brought about a clogged supply have also reduced the moisture storage capacity of the soil. Long summer droughts of six to eight weeks duration make these Blackland soils wholly dependent on their ability to store enough available water to provide for growing plants. When in good condition, these soils were abundantly capable of withstanding droughts since they could store as much as 12 inches of available water in a three-foot depth of soil. But after 60 to 80 years of cultivation with no deep-rooted legumes or grasses in the subsoil since the last prairie grass roots rotted and disappeared, the once spongy soil now resembles a brick.

Available moisture studies show that cotton land now stores only one and three quarters inches of available water per foot of topsoil, while the subsoil stores about two inches. Counting one foot of topsoil and two feet of subsoil this means a storage capacity of 5.75 inches. Using a rough rule of thumb that one inch of water per week is needed to keep crops actively growing during the summer, these soils could go almost six weeks without a rain, if the cotton roots were well distributed through the three feet of soil.

On these same soils, where deep-rooted legumes have been used only a few years, sufficient to improve the visible structure, the available water storage is increased to 2.5 inches per foot in the topsoil and 3.25 inches per foot in the subsoil. Using the same rates of one foot of topsoil and two feet of subsoil this gives nine inches of available water in the three-foot depth of soil. This represents nine weeks of water for the actively growing crop or a gain of three weeks' supply of water over the soil with poor structure.

Ability to take water and ability to store water are separate factors, and each must be considered. Storage capacity, though large in Blackland soils, is meaningless unless the intake rate is sufficient to refill the soil at each opportunity.

Soil Structure an Important Factor

To demonstrate the relationship of soil structure, both

Table 1. Average Intake Rates

	Fine textured soils		Medium textured soils
	Very slowly permeable soils Inches per hour	Slowly Permeable soils Inches per hour	Very slowly permeable soils Inches per hour
Continuous row crops	0.42	1.35	0.57
Range of Values	0.25 - 0.75	0.03 - 4.3	0.5 - .75
Legumes one or more years	1.91	4.19	1.0
Range of Values	0.75 - 3.0	0.72 - 8.0	0.25 - 1.8

good and poor, to available moisture storage and intake rates, tests were made on adjoining fields on the Moncrief farm near Arlington, Texas. The soil was deep, fine-textured, slowly permeable Blackland. One set of samples and intake runs were made on a Madrid clover field, where the soil structure was good. Twenty feet away another set of samples and intake runs were made in a field that had been in continuous cotton and had developed a dense plow pan at about five inches. The results are given in the following table:

Table 2. Available Water

	Topsoil in/ft.	Subsoil in/ft.	Total in 36"	Intake rate in/hr.
2nd year Madrid	2.5	3.25	9.0	4.8
Continuous row crop	1.6	2.14	5.88	0.3

From these results, and similar ones obtained in many parts of the Blackland, it is evident that the soil suffers doubly from its poor physical condition. Not only is the storage capacity impaired so that the soil needs rain three weeks sooner, but when rain does come the soil is ill-prepared to catch it. Rains that commonly fall in May and June should recharge the soil, but few fall slowly enough to fill a soil where the measured intake is only 0.3 inches an hour.

On the other hand the soil with an intake rate of 4.8 inches an hour is ready to catch rain and re-fill its larger tank. The soil that worst needs the moisture is least likely to catch the rain, and water which runs off not only is completely lost for crop production but frequently carries with it many tons of fertile topsoil.

The poor physical condition widely found where cotton has been continuously grown has produced another strikingly bad effect. Cotton, normally a strong tap-rooted plant, finds the plow sole so dense that the tap root is unable to go down in a normal manner. Roots go to the plow pan and then fan out in a blunted, deformed fashion. Old-timers tell that cotton roots used to be long and tapered, and some recall whippings they got with cotton roots.

That kind of cotton root, with 18 to 24 inches of gradual taper, now is found only on those farms where enough deep-rooted legumes or grasses have been used to restore a good soil structure. Many farmers, when questioned about why cotton roots are so shallow, reply "They are breeding the tap roots off the cotton in the improved varieties," although there is no record of cotton breeders giving root characteristics any consideration. This shortened root simply puts the cotton plant even more at the mercy of the weather.

Though the soil cracks deeply during the late summer, and winter rains recharge the soil through these cracks, when the growing season comes the cotton plant is unable to send its root to the deeply stored water. Likewise the plow pan is so dense that capillary movement of water upward through the pan is practically non-existent.

The plow pan serves as a barrier, preventing root penetration or upward water movement. It is not uncommon to find fields of cotton wilting in the afternoon, yet below the plow pan the soil is wet enough to make a mud ball. It's a situation comparable to trying to drink a half-full bottle of cola with a two-inch straw.

Despite improved varieties, better insecticides, power machinery, and retirement of steep land from cultivation, per acre cotton yields have at best only held their own and in many cases have decreased.

Summary

Some farmers try expensive irrigation schemes, while

(Continued on page 199)

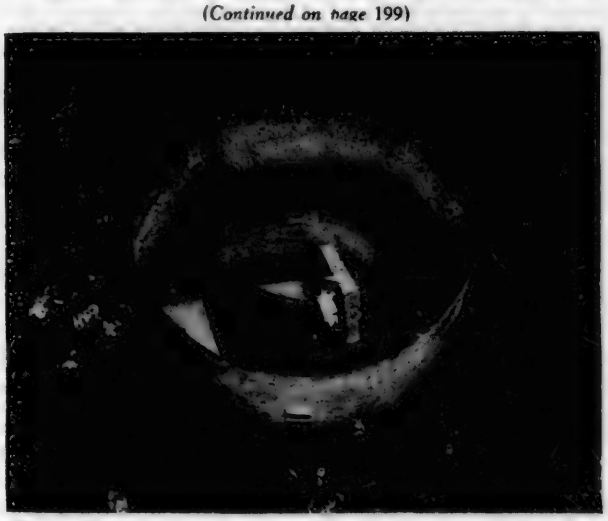

Figure 2. Measurement devices like this have proved that there are wide variations of water intake within a single soil, depending on the treatment the soil has received.

Report of Investigation

1951 Kansas Flood Area

HAROLD J. SWAN

Losses caused by the disastrous flooding in Kansas during July, 1951, are estimated at more than a billion dollars. Fully 40 per cent of these losses occurred on the upland and along the flood plains of the tributary streams where presently authorized flood control programs would afford no protection. These statements are contained in a report of an investigation of the Kansas Flood Area recently issued by the Soil Conservation Service.

OF THESE LOSSES, $108,350,000 were on the flood plains of the tributary streams where, the Soil Conservation Service estimates, damages could have been reduced by 38 per cent by the application of runoff and waterflow retardation and soil erosion prevention to the watersheds. This program would include, in addition to the application of complete soil and water conservation plans to the farms and ranches, upstream flood control measures such as floodwater retarding reservoirs, floodways, channel improvement, waterway improvement, grade stabilization structures and diversion dikes.

Damage to Upstream Areas Heavy

Losses in fertile topsoil through erosion and damage to crops on the upland, where the torrential flood-producing rains fell, are estimated at over $310,000,000. This includes over $110,000,000 damage to upland crops and more than $200,000,000 damage to the land through erosion. No estimates were made of the affects of the program on these lands. Investigations in other areas where intense rainfall has caused similar damages indicate, however, that a complete soil and water conservation program could have reduced the damage to the upland by from 30 to 90 per cent, depending on the character of the watershed.

Slightly over 85 per cent, or $92,150,000, of the damages along the flood plains of the tributaries was done to agricultural establishments and crops. This included damage to farm buildings, fences, farm machinery and equipment, and loss of livestock. These losses, it is estimated, could have been reduced by $35,890,000 by the application of the above-mentioned program.

Land damages through scour, deposition, streambank erosion, and swamping were placed at $9,370,000, or 8.7 per cent of the flood plain losses on the tributaries. This, it is estimated, could have been reduced by $3,100,000.

Other flood plain damages, $6,830,000, concern silting of reservoirs. Of this, it is estimated that silt deposits in existing reservoirs occupy storage space valued at $4,690,000, while the silt deposits would have occupied storage space valued at $2,140,000 in presently authorized and partially completed reservoirs had they been in operation at the time of the flooding. These damages, it is concluded, could have been reduced by $2,660,000.

Altogether, these reductions in damages on the tributary streams would have totaled about $38,990,000 had there been a complete program of runoff and waterflow retardation and soil erosion prevention on the watersheds. The reduction in damages would come in three different ways—by reducing the area flooded, by reducing the depth of inundation, and by shortening the period of flooding for certain areas.

But statistics do not tell the whole story. The watersheds of these tributaries total 93,696 square miles in Kansas, Nebraska and Colorado. Almost 53 per cent of the land is under cultivation, 39 per cent in native hay and pasture, two per cent in woodland, and the rest devoted to miscellaneous uses. From central Nebraska eastward and including roughly the eastern third of Kansas, the area is principally one of intensive corn, small grain and livestock production. Elsewhere, the area is devoted largely to winter wheat and extensive grazing lands. In the east, woodlands are in the more hilly and dissected sections; in the western parts, they are principally in the valley bottoms.

In the eastern part, crops are produced abundantly under dryland conditions on the alluvial bottoms that border most of the streams and tributaries. In the western portion, some bottomlands have been developed for irrigation. In many cases, the report points out, the floods such as were experienced this summer result in virtually complete loss to such individuals.

Economic Stability of Areas Is Disrupted

So, the report points out, the affects of the flood are more far-reaching than the immediate monetary loss. Instead, it disrupts the economic stability of the area through land damage, increasing the costs of operations, and causing the abandonment of land because of the resulting high risks of farming it.

The period of flooding was long drawn out, the report

Harold J. Swan, a Charter member of the SCSA, is Head, Current Information Section of the Soil Conservation Service. His headquarters are in Lincoln, Nebraska.

points out. The disastrously high water in the lower reaches of the Kansas (Kaw), Osage (Marais des Cygnes) and Neosho rivers was preceded by extended rain periods that caused flash floods in some small streams in May, and maintained high stages in most of the larger streams during June for the longest period known in the history of weather records.

Damages to agriculture on the flood plains was found to have varied considerably between watersheds. This is because of the differences in the amounts and intensities of rainfall, the physical characteristics of the watershed lands, and the damageable values found on the flood plains. Rainfall on the headwaters of the Marais des Cygnes, Neosho and Verdigris rivers greatly exceeded that in the upper portions of the Smoky Hill, Solomon and Republican, and the flooding was of greater proportions in those tributaries. Grass cover on the Flint hills portion of the drainage areas resulted in much less severe sediment damage in some streams.

In conclusion, the report also presents an estimate of the reduction in average annual damages on the flood plains of these tributaries where the presently authorized flood control programs would afford no protection. These take into account the year to year affects on the minor floods that occur on some of the tributary watersheds every year.

It is estimated that application of a program of upstream flood control and land treatment measures would reduce the average annual sedimentation and land damages by 63 per cent.

Problems of Drainage

(*Continued from page* 186)

corn belt soils are droughty because they are too wet. The corn plants suffer from drought late in the season because they have had too much rain earlier.

Compared to the Corn Belt, drainage problems of New England are associated with more sandy soils. According to the drainage census, only one acre out of fifty in the crop land of New England needs drainage. This same census shows that one acre out of every three of crop land in the state of Ohio requires drainage.

Because of the diversity of soil types, crops, and topography, the Northeast drainage conditions are in many ways more complex than those found in the Corn Belt.

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Conservation Effects on a Sandy Soil

(*Continued from page* 190)

program in this Coastal Plain area.

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Rate of Water Intake

(*Continued from page* 197)

others try new fertilizers. But an increasing number of farmers are quietly solving the problem by growing deep-rooted legumes in rotation with cotton and other cash crops. These legumes are bringing back good soil conditions. Though few fields yet have reached that meaningful goal of "new land," the improvement is noteworthy.

The active organic matter supplied by these same legumes has beaten the bugaboo of root rot, reducing it to a fraction of that occurring on non-legume land. With more of the rain caught and stored, there is less moisture to run off the land with the attendant damage of erosion, flood loss, and siltation of reservoirs. Cotton yields have been increased from 50 to 100 per cent on Blacklands where deep-rooted legumes have been used sufficiently to open the soil and catch more of each rain. This is just a beginning with no added fertility except phosphate in some cases under the legumes. When the physical condition of Blackland soils is improved to the point where the water caught and stored exceeds the present fertility level, then fertilization with commercial fertilizers will be useful to increase yields further.

Conservation Farming on Experimental Watershed Increases Farm Income

JOHN A. ALLIS

Results at the Soil Conservation Service Experimental Watershed near Hastings, Nebraska, indicates that corn raised under conservation methods last year was worth at harvest time from $7.20 to $10.80 more an acre than corn raised by up-and-down-hill farming.

This is the fourth year in a row—actually, every year since the present series was begun—that conservation farming paid out on these tests. The difference between results from conservation and straight-row operations has varied from year to year, of course, but total corn production during the four years from conservation farming is over 22 per cent more than from straight-row operations.

The principal activity for which the station was set up is the study of the effects of conservation measures on the behavior of runoff from small watersheds. Some things are beginning to show up in the study that are putting two and two together to make four. Namely, conservation practices help to reduce flood flow, and moisture conserved by this runoff control benefits crops.

The scope of the station's activities covers leased land, and land that is privately operated. Topography is rolling, soil on the heavy side, and ground water level 50 feet or more below the surface so that it cannot complicate the station's work. Operated in cooperation with the University of Nebraska experiment station, the site was selected as representative of the Central Great Plains.

Tests are conducted on small watersheds of approximately four acres each of which are as nearly alike as peas in a pod. Three-year crop rotations of corn, oats and wheat are followed. Straight row, contour, and subsurface tillage farming methods are practiced. There are duplicate and triplicate watersheds in each crop and for each method of farming, making 21 watersheds in all.

The corn crop last year on the small watersheds was the start of the second sequence of the crop rotation. These watersheds were in corn in 1947, in oats or wheat in 1948 and 1949. Likewise each of the other watersheds had been in corn one year.

Corn yields from duplicate watersheds farmed up-and-down-hill averaged 26.6 bushels an acre last year, or considerably less than from the others. Those that had been subsurface tilled on the contour yielded 33.8 bushels an acre, while those where only contour farming was practiced yielded 31.4 bushels an acre.

Thus, based on corn prices at harvest time in 1950, the subsurface tilled watersheds produced $10.80 more income an acre than those farmed up-and-down-hill, and the contoured corn, $7.20 an acre more.

During the four-year period, the subsurface-tilled watersheds topped contour farming in corn yields twice —by 2½ bushels an acre in 1950 and one bushel in 1948. But in 1948. But in 1949, the contoured fields topped the subsurface-tilled fields by five bushels an acre, and in 1947, by one-fifth bushel an acre.

Nevertheless, the four-year average production from the subsurface-tilled and contoured watersheds was almost even. The total corn production per acre for the four years was: up-and-down-hill farmed, 92.4 bushels; subsurface-tilled, 112.7 bushels; contour listed, 114.6 bushels.

Records for oats and wheat production are less complete, because green aphis damaged the oats in 1949. In 1948 and 1949, oats had to be substituted for wheat on the watersheds supposed to be in wheat, because of the poor wheat stands that existed in the spring.

In the years for which small grain measurements were made, contoured and up-and-down-hill farmed water-

Photo by Soil Conservation Service

Figure 1. Numerous devices have been installed at the Soil Conservation Service experiment station near Hastings, Nebraska in order to obtain accurate measurements of runoff and thus ascertain the affects of conservation on the runoff of water from sloping land. This shows a V-notch in a drainage, with water stage recorders protected by shelter houses.

John A. Allis is Project Supervisor, Soil Conservation Service-Research. His headquarters are at Hastings, Nebraska.

Photo by Soil Conservation Service

Figure 2. During the years, corn yields from the small watersheds on the Soil Conservation Service experiment station near Hastings, Nebraska, that were contour farmed and those that were subsurface-tilled on the contour total almost even. Both have produced considerably more than the small watersheds farmed up-and-down-hill. The above pictures were taken in 1948, one of the years when the subsurface-tilled watersheds topped the contoured plots. They give a graphic illustration of the difference between conservation and non-conservation farming. The top picture shows the corn harvested from the small watersheds farmed up-and-down-hill; the center picture shows the corn from the contour watersheds; and the bottom picture shows the corn from the subsurface-tilled watersheds. The acreage was the same in all cases.

sheds produced just about equally, but the subsurface-tilled watersheds yielded a little less an acre.

Peak rates of runoff—that is, the highest rate during a storm at which water ran off a field—were determined on the small watersheds for ten storms during 1950. The peak rates were from 27 to 26 per cent less an watersheds where conservation farming was practiced.

In addition, water flow measurements have been started on a 411-acre watershed and one of 481 acres—both where no soil and water conservation had been practiced. Since the establishment of gaging stations to measure water flow from these watersheds, conservation practices have been applied on about 65 per cent of the 411-acre watershed. All but one of the operators with land in it are cooperating. The practices include terraces, contour farming, stubble mulch tillage, an improved crop rotation, and grass waterways.

Runoff from the larger watersheds was measured for two storms last year—July 8-9 and September 19-20. A little over six inches of rain fell in the two storms, with the partially protected watershed receiving about a third of an inch more than the other.

Runoff from the unprotected watershed was 2.65 inches out of the 6.02 inches received, compared with only 2.21 inches runoff out of 6.35 inches received from the partially protected watershed. Thus, over three-fourths of an inch more was saved on the latter watershed than on the one where no conservation is practiced.

The measurements that have been started on the larger watersheds are for the purpose of determining the extent to which conservation practices can be expected to hold water on the land, reduce flood crests of the creeks and rivers, and increase crop production per acre. This study is one of the few in the United States where actual measurements are being made on a watershed basis.

Factual data from the larger watersheds is far too limited yet to draw definite conclusions. Indications point, however, to some reduction in total runoff and, at least equally important, to a reduction in the rate at which runoff reaches the streams. Crop yields on the small watersheds indicate that the evident reduction in runoff through conservation farming brings considerable gains in crop yields and, consequently, higher income for the farmer.

"It were happy if we studied nature more in natural things; and act according to nature, whose rules are few, plain and most reasonable."

—Wm. Penn.

Soil Layers Causing Runoff from Hard-Land Wheat Fields in Colorado and New Mexico

C. H. DIEBOLD

The author describes a portable infiltrometer which has speeded up field determinations of water intake and runoff on hard-land soils for two seasons. Length of cultivation, chiseling when dry and chiseling when moist are related to runoff on hard-land wheat fields. A method is presented for predicting infiltrometer rates from core samples. Procedures are given for locating the limiting layer causing runoff and the relation of soil characteristics to intake rates is described.

RUNOFF FROM DRY FARM lands in eastern Colorado and eastern New Mexico is becoming increasingly serious. Precious water is not only lost but with it valuable topsoil. Observations indicate that the length of time that the land has been in cultivation and the moisture content of the soil when tilled both influence runoff and erosion. What layers in the soil are responsible for runoff? Is stubble mulch alone adequate to control runoff?

Preliminary studies showed that it would be necessary to study not only the intake rates of soil cores representative of the different soil layers (10) but also infiltration rates at the soil surface (2) (8) (11). Simulated rainfall such as produced by the type F infiltrometer has produced runoff more closely approaching watershed rates than other infiltrometers. Unfortunately the type F is costly to operate. To facilitate this study a portable infiltrometer was designed and constructed which permitted needed replications at a reasonable cost.

Portable Infiltrometer

In 1949, a special trailer was built to carry an aluminum shelter 8′ x 8′ x 9′ riveted to an angle-iron frame (figure 1). This shelter was necessary to protect the simulated rainfall from the wind. The original shelter was eight feet high but was later reduced to six feet to make it more easily handled. Two men can lift the shelter off the trailer safely except in windy weather. The feed pipes were bolted to the angle-iron base of the shelter and four type-F nozzles were screwed into tees spot-welded at an angle of nine per cent toward the plot. The use of this portable shelter and trailer eliminated the need for a stake-body truck and saved two man hours per plot.

A further reduction in cost, accompanied by better performance, was obtained by utilizing a power take-off from the transmission of the pickup to operate a ¾ inch Fairbanks Morse rotary pump with a bypass. This unit operated so uniformly at 35 pounds pressure that we did not need a surge tank.

By using a three trough 12 gage galvanized steel rain gage (12) which bisected the plot, an aliquot portion of the rainfall was obtained continuously during the run. Thus, we did not need calibration runs before and after each trial, thereby saving 20 minutes per run as well as the transport of 45 gallons of water. This reduced the water needed to 135 gallons for a run lasting one hour. This amount could be carried safely on a ½ ton pickup (figure 2).

We measured all of the runoff from our 5′1″ x 6′ plot by utilizing buckets and point gages from the North Fork equipment. Runoff and rainfall were measured every six minutes and converted into inches per hour using tables. Since all measurements were in tenths of

Figure 1. Complete portable infiltrometer equipment mounted on special trailer and ½ ton pickup. In the pickup bed there was space for core sampling equipment, tanks for permeability work, electric oven, soil moisture cans and two 125 gallon tanks; one of the tanks is mounted permanently on the pickup.

C. H. Diebold is Soil Scientist engaged in special studies for Soil Conservation Surveys Division, with headquarters at the Soil Conservation Service Regional Office, Albuquerque, New Mexico. Among those who assisted with the field work were: E. M. Payne, Fred Case, L. M. Keesey, T. B. Moore, B. K. Bateman, H. J. Maker, Jim Ross, William Buchanan and Don McLeod of the Soil Conservation Service and D. S. Romine of the Colorado Agricultural Experiment Station. Laboratory data were reported by J. A. Williams, Marvin Seal and Robert Accola. Many others helped for shorter periods.

an hour, we could readily keep cumulative totals of runoff and infiltration during the run. So, we were able to quickly detect sources of error during the run and eliminate many office calculations.

Factors Affecting Infiltrometer Intake Rates

Cultivation: At the Akron Dry Land Experiment Station, Akron, Colorado, we compared fallow soils which had been farmed 30 years with virgin blue grama-buffalograss range which was in good condition. The surface soils were loamy, containing from 47 to 50 per cent silt and from 1.1 to 1.5 per cent organic matter in the cultivated fields. The slopes varied from ½ to 2 per cent. In order to simulate the beating action of high intensity storms we used four type F nozzles at 35 pounds pressure to produce an initial storm of two inches in one hour. On the following day a second two inch storm was produced in one hour (wet run). The frequency of a two-inch storm in one hour is once in 12 years at Akron.

At Akron, lumps of soil from all six crusted fallow soils, slaked after receiving from seven to 15 drops of water, whereas, lumps of soil from the good pasture sites remained intact after receiving 25 drops or more. On the unstable crusted fallow soils, the runoff from the initial storm of two inches, varied from 43 to 60 per cent. In contrast there was but five to 20 per cent runoff on the good pasture sites. Although we stored .4 inch more water by duckfooting the crusted fallow Rago soil just before our infiltrometer run, the intake rate was similar to the crusted soil after 30 minutes (figure 3). Owing to the instability of the surface soil in cultivated fields, there is a serious runoff problem, in spite of slopes of less than two per cent.

On the day following the initial run, we applied another two-inch storm in one hour to each of the 12 sites. About half as much water entered the wet fallow crusted Weld and Colby soils as on the day before. Worse yet on the Rago, only one-fourth as much water entered the soil. Even on the freshly duckfooted Rago there was 77 per cent runoff. In contrast with these high runoff values from fallow soils, only 40 per cent of the storm was runoff on the good blue grama-buffalograss sod for the same soil. Infiltrometer studies by the Bureau of Reclamation on the same soils also indicated that runoff was a serious problem (4). You can see that the runoff problem has greatly increased as a result of 30 years of cultivation.

Figure 2. Operating infiltrometer on wheat stubble near Akron, Colorado. Pit at left is for core samples.

Soil Unit[a]	Soil Series	Condition	Initial Storm % Runoff	Second Storm % Runoff
2M23	Rago	Crusted fallow	60	92
2M3cl	Weld	Crusted fallow	47	71
2M3	Colby	Crusted fallow	43	65
2M23	Rago	Fresh duckfoot fallow	43	77
2M23	Rago	Good blue grama-buffalograss	20	40
2M3cl	Weld	Good blue grama-buffalograss	5	38

[a]Standard symbols for Soil Conservation Surveys (Land Capability Inventory). Supplement (Feb. 15, 1951) to Guide for Soil Conservation Surveys, Washington, D. C., 1948, as it pertains to soil units described herein.

Chiseling when Dry: Tests on the effect of chiseling dry soils were conducted near Akron, Colorado on a field of wheat stubble with a tillage pan. Here in August,

Effective Depth	Texture of Topsoil	Permeability of first significant zone under present topsoil	Permeability of second significant zone under present topsoil
1. Very deep 60 in. or more	V Very Heavy	1. Very slow (Less than .05 in/hr)	1. Very slow (Less than .05 in/hr)
2. Deep 30-60 in.	H Heavy	2. Slow (0.05-0.20 in/hr)	2. Slow (0.05-0.20 in/hr)
3. Moderately deep 20-36 in.	M Medium	3. Moderately slow (0.20-0.80 in/hr)	3. Moderately slow (0.20-0.80 in/hr)
4. Shallow 10-20 in.	L Light	4. Moderate (0.80-2.50 in/hr)	4. Moderate (0.80-2.50 in/hr)

Z Gravel
R Caliche

c1 First significant layer under present topsoil, thin, 0-6 inches.
c2 First significant layer under present topsoil, moderately thick, 6-12 inches.

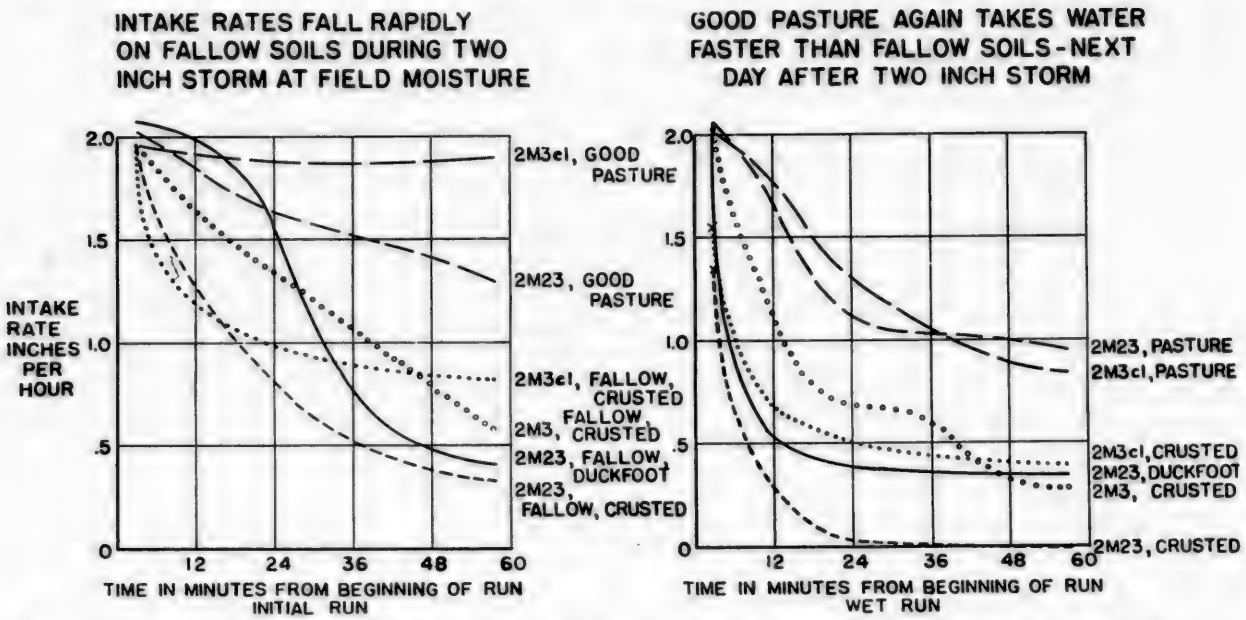

Figure 3. Comparison of average intake curves from initial and wet runs using storms of two inches per hour on soil units: 2M23 (Rago Loam), 2M3cl (Weld Loam), and 2M3 (Colby Loam). The slopes varied from ½ to 2%. U. S. Dry Land Experiment Station, Akron, Colorado, September, 1949.

1950, the field was stubble mulched for the first time when the soil was dry and hard. In contrast to the previous soils studied which had developed from loess, this soil had developed from arkosic outwash, soil unit 3M2Zc2, Platner fine sandy loam. The clay content increased rapidly from 9 per cent in the surface to 20 per cent at three to six inches and progressively to 38 per cent at eight to 11 inches. Owing to recent heavy rains in September just before our studies, the surface foot was near field capacity in both paired areas of untreated stubble and chiseled stubble. The slope was two per cent. Here we could find out how much chiseling the soil when dry influenced intake rates.

You can see in figure four that chiseling the sandy clay loam tillage pan five inches deep and 12 inches apart on the contour increased the intake rates for both the initial and the wet runs. The chiseled soil took .6 inch more water during the initial storm and .4 inch more during the wet run. Our soil moisture samples taken before the initial storm showed that there was .3 inch more available in the 0-2 foot depth in the chiseled area than in the untreated area. Although chiseling when dry was beneficial, runoff remained a serious problem on this field.

Condition	Initial Storm Per cent Runoff	Second Storm Per cent Runoff
Stubble no treatment	60	81
Stubble chiseled	31	64

Chiseling when Moist: Is chiseling effective at higher moisture contents when it is easier to pull the equipment? Such data were secured from infiltrometer studies near Wray, Colorado, on soil unit 2M43, Colby and Ulysses series. There were moderate tillage pans; the surface soils contained 36-41 per cent silt and 1.4 per cent organic matter. In September, 1950, the surface foot at all eight sites was close to field capacity. The two sites which had been recently chiseled four inches deep on the contour contained 1.7 inches more available moisture in the 0-3 foot depth than the untreated wheat stubble. Although the crusted chiseled stubble took .3 inch more water during the initial two inch storm, the reverse occurred on the wet run (figure 5). More runoff from the wet run on the chiseled area is attributed to not only failing to break the tillage pan, but also to additional compaction.

Condition	Initial Storm Per cent Runoff	Second Storm Per cent Runoff
Crusted seeded	33	56
Crusted stubble, chiseled 4 inches deep	26	64
Crusted stubble no treatment	42	52
Fresh bladed stubble	4	43

During these studies, while the moisture content of the surface foot was close to field capacity, we bladed one area four inches deep and another six inches deep

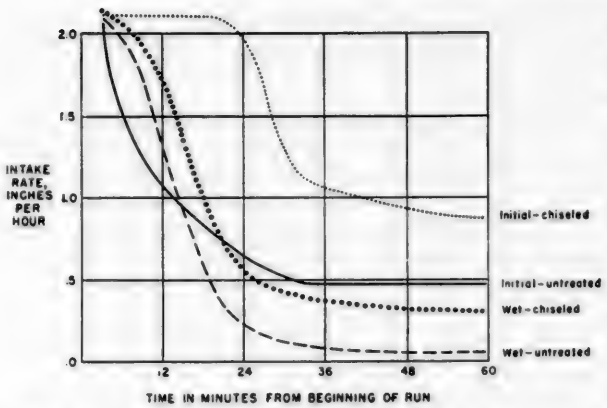

Figure 4. Comparison of curves for chiseled wheat stubble and wheat stubble untreated for both initial and wet runs using storms of two inches per hour, soil unit 2M2Zc2, Platner fine sandy loam (arkosic), Gebauer farm, Akron Soil Conservation District, Colorado.

using a blade five feet wide. Blading fluffed up the soil so that little or no runoff occurred during the initial run. However, runoff from the second storm approached that of the untreated areas. Our core studies show that a new tillage pan was created just below where the blade had sheared through the moist soil. Furthermore, we could see many of the shingle-like layers of the old tillage pan. Similar intake rates were obtained from both depths of blading. So, if you chisel while the soil is moist, you may create a new tillage pan.

In eastern New Mexico in the vicinity of Clovis we found tillage pans in all of the hard-land wheatfields, just as we had in Colorado. Owing to runoff from these fields, some farmers had tried to chisel during July and August, 1949, when there was much moisture in the surface soil. In November, 1949, we made infiltrometer studies on a newly seeded wheat field on soil unit 2M23, Pullman loam which had been one-wayed and chiseled eight inches deep in July and August. In November, we were unable to find any evidence that the field had been chiseled. Runoff from the initial storm was 24 per cent and from the wet run 56 per cent. These rates of runoff were similar to ten other trials made on Pullman soils in eastern New Mexico in 1949 and 1950. You can conclude that chiseling clay loam subsoils at moisture contents close to field capacity may often fail. Studies are needed to determine the range of moisture suitable for effectively shattering tillage pans.

Prediction of Infiltrometer Intake Rates from Core Samples

In order to evaluate permeability of the different soil layers, a minimum of six soil cores were taken from each layer. These cores were three inches in diameter and three inches long. After fastening an empty cylinder with scotch tape on top of each filled cylinder, the cores were placed on a netting of hardware cloth ½ inch above the floor of an empty tank with an outlet. Next, we maintained a variable head of one inch of water on each core for two hours (adding one inch of water and repeating when all of the water had entered the soil). At the end of both one hour and two hours, we measured the depth of water which entered the soil at field moisture. Then we filled the tank with water nearly to the top of the cores to allow more complete saturation and force out entrapped air. On the following day, we determined the saturated permeability rate using a variable head of one inch of water for one hour.

Initial Infiltrometer Runs: The multiple correlation coefficient R was significant at the 5 per cent point (9) for average intake rates from infiltrometer runs and median core intake rates for the first hour from both the surface soil and tillage pan. The comparative data were taken from 16 sites of wheat-fallow on hard-land soils in Colorado and New Mexico. The regression equation was $E = .97 + .10X_1 + .33X_2$.

X_1 is the median core rate of the surface soil for the first hour.

X_2 is the median core rate of the tillage pan for the first hour.

The regression of initial infiltrometer intake rate on X_1 was significant at the 5 per cent point whereas that on X_2 was not quite significant. Thus, the average initial infiltrometer intake rate was influenced more by the surface soil than by tillage pans. Remember that most of the unfilled storage of the surface soil must be filled before the tillage pan can exert its bottleneck effect on runoff.

Soil Unit	Soil Series	Condition	Initial Storm Per cent Runoff	Second Storm Per cent Runoff
2M23	Pullman	One way, chiseled, crusted seeded	24	56
2M2R	Pullman	One way, crusted volunteer wheat	33	70
2M2R	Pullman	Duckfoot crusted, seeded	20	68
2M24	Pullman	One way, fresh, seeded	6	49
2M34	Pullman	One way, crusted, seeded	35	60
2M24	Pullman	One way, chiseled 12 inches deep, ten feet apart, seeded	22	64
2M34	Dalhart	One way (one field chiseled but not deep enough to be effective) volunteer wheat	13	74

Could we better predict initial infiltrometer intake rates from core data if we used both unfilled storage below field capacity and 80 per cent of the temporary storage? For example, a 0-4 inch layer with a total storage capacity of 1.16 inches would be filled in .61 hour using the first hour core intake rate of 1.91 inches per hour. Next the 4-10 inch depth with an intake rate of .47 in/hr would put .18 inch in this layer in the remaining .39 hour. So, the predicted rate would be 1.34 inches for the initial infiltrometer run. Using this procedure for 17 sites, 59 per cent of the sum of squares were explained by the regression equation as compared with 44 per cent when we used initial core rates from both the surface soil and tillage pan without storage. Thus, we can improve our predicted rates by using storage values with the core rates.

Of even more significance, a storm would have to last longer than one hour before the subsoil could become a limiting factor under the conditions studied. Thus, our core data indicated that intake rates of the surface soil and the tillage pans were such that more than one hour would be required to fill the surface soil and tillage pan during the initial run. Obviously, subsoil permeability is not related to initial infiltrometer intake rates in our studies.

Wet Infiltrometer Runs: Just as we improved our prediction of initial intake rates by including storage with the core rates, we likewise improved our predicted wet infiltrometer intake rates. Nearly half of the water entering the soil during the wet run refilled temporary storage. In our calculations we used 80 per cent of the temporary storage assuming that the volume of undrained pores was about offset by the decrease in entrapped air. The inclusion of loose surface soils from two sites gave such a large error that the correlation coefficient was not significant. Excluding these two sites, there was a significant correlation, $r = .70$, between our predicted rates using 80 per cent available storage and average wet infiltrometer intake rates. The equation was $E = .43 + .60X$. Therefore, core rates can be used to predict infiltrometer intake rates if we include storage.

Location of Limiting Layer

On dry farm land where we may expect a storm of two inches in one hour but once in 12 years, does subsoil permeability affect runoff? First, what depth of soil is required to temporarily hold two inches of water? So, we took soil moisture samples by layers prior to our infiltration studies, from ten to 30 minutes after the wet run, and in a number of areas two days after the wet run, to determine field capacity. In order to express the soil moisture data in terms of inches of water, we took volume weight samples. These cores were saturated overnight and weighed to determine the total pore space. So, if we know the volume of unfilled storage below field capacity plus the volume of pore space above field capacity which can be temporarily utilized, we can estimate the total storage capacity above any limiting layer. If this amount is less than our design storm of two inches, then that layer could be limiting.

Since the volume of pores above field capacity often exceeds the amount of unfilled storage below field capacity, you should determine the amount of temporary storage utilized under field conditions. For medium

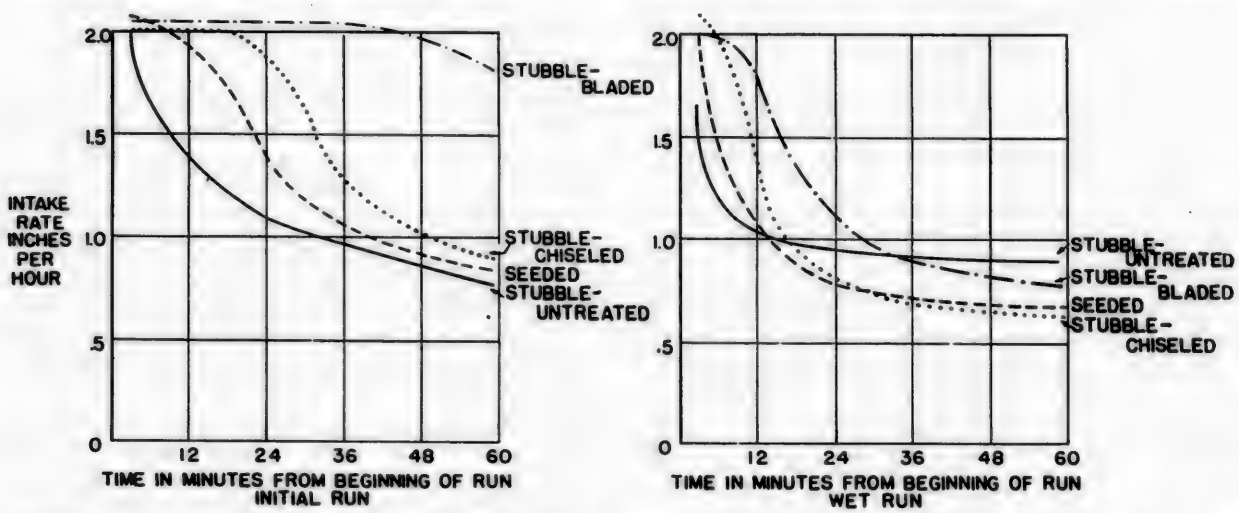

Figure 5. Comparison of average intake curves from initial and wet runs using storms of two inches per hour on wheat, soil unit 2M43, moderate tillage pans, 36-41% silt, slope 8%, and 1.4% organic matter. Renzelman Farm, Hale Soil Conservation District, Colorado.

Table 1. Relation between soil unit, treatment, volume weight, field capacity and the minimum depth required to hold temporarily a two-inch storm, hardland wheat fields in Colorado and New Mexico.

Soil Unit	Soil Series	Depth Inches	Volume Weight	Pore Space In/Ft	Field Capicity In/Ft	Total Storage[a] ¼[b] In	¾[b] In	F[b] In	Minimum Depth to Store 2.0" Storm ¼[b] In	¾[b] In	F[b] In	Observed Temporary Storage[c] %	In/Ft
2M43	Colby	0-3	1.27	6.2	3.4	.9	.7	.6	7	9	12	44	1.2
	Stubble	3-8	1.37	5.8	3.4	1.4	1.0	.8				55	1.3
		8-20	1.22	6.5	3.4	4.0	3.0	2.5					
3M2Zc2	Platner	0-3	1.57	4.9	3.0	.8	.5	.4	8	12	16	100	1.9
	Stubble	3-6	1.46	5.4	3.6	.7	.5	.4				44	.8
		6-14	1.26	6.3	4.5	2.0	1.3	1.0				0	.0
3M2Zc2	Platner	0-3	1.34	5.9	3.0	1.0	.7	.6	6	10	13	69	2.0
	Stubble	3-6	1.30	6.1	3.6	.9	.6	.5				36	.9
	Chiseled 5" deep	6-14	1.25	6.3	4.5	2.0	1.3	1.0					
2M23	Rago	0-3	1.48	5.3	3.4	.8	.6	.4	8	12	17		
	Fallow	3-8	1.48	5.3	3.6	1.2	.7	.6				55	1.0
		8-18	1.34	5.9	3.8	2.4	1.6	1.2				8	.2
2M24	Pullman	0-3	1.36	5.8	3.6	.8	.6	.4	9	14	22	51	1.2
	Seeded	3-12	1.47	5.3	4.0	1.9	1.1	.8				12	.2
	Chiseled	12-24	1.51	5.2	4.0	2.5	1.5	1.0				0	.0

[a]Total storage consists of 80% of the pore space occurring between field capacity and saturation plus unfilled storage, below field capacity.
[b]Readily available moisture F being field capacity.
[c]From soil moisture data taken from 10 to 30 minutes after wet run expressed in amount of moisture above field capacity, temporary storage.

textured soils where the surface soil is not the bottleneck layer, we found approximately half of the temporary storage remained filled in the 0-5 inch depth immediately after the wet run on soil unit 2M43, Colby. Here the tillage pan at three to six inches was limiting. In contrast, on soil unit 2M24 also with a tillage pan at the same depth we found 73 per cent of the temporary storage filled in the 0-3 inch depth. For similar conditions on soil unit 3M2Zc2, Platner, 100 per cent of the temporary storage was filled. (table 1.) In contrast, adjacent areas, which were chiseled when dry, had only 69 per cent of the temporary storage filled. Similarly on the chiseled 2M24 soil, but 32 per cent of the temporary storage was filled above the broken tillage pan. Our limited data indicate that half of the temporary storage will remain filled a few minutes after a two inch storm on 2M43 soils with a tillage pan and 2M24 soils which were chiseled when dry. In contrast, roughly 80 per cent of the temporary storage remains filled on 2M24 and 2M23 soils with tillage pans. However, where the surface soil was limiting we found only half of the temporary storage utilized on 2M3, 2M3cl and 2M23 soils. Under storm conditions, 80 per cent would appear to be a reasonable figure of the temporary storage that is utilized on the soils studied.

Now if a two inch storm occurred when one fourth of the available moisture was present, table 1 shows that only six to nine inches of soil would be required to temporarily store it. However, if the soils were at field capacity, soil unit 2M43 with a tillage pan would be filled to 12 inches and soil units 2M23 and 2M24 from 16 to 22 inches. Note that by chiseling a compact 3M2Zc2 soil we reduced the minimum depth to store two inches of water from 16 inches of soil to 13 inches of soil (table 1). If the intake rates of the surface soil and tillage pans were improved by remedial measures, slowly permeable layers in the upper subsoil could become limiting. Under present conditions with a tillage pan, limiting layers in medium textured soils would occur only in the surface foot, and in moderately heavy soils only in the 0-2 foot depth.

In the preceding calculations, 2.1 inches per foot has been used as the maximum amount of readily available moisture for both medium and moderately heavy textures. Limited data confirm this figure which was originally derived from irrigation trial data in New Mexico (3) when crops were showing stress. Apparently the higher field capacity values of the moderately heavy soils are offset by equally higher amounts of less available water. Under semi-arid conditions, crops show stress when soil moisture is appreciably above wilting point. Note that Blair, Richards and Campbell (1) recently reported that the growth rate of sunflowers was markedly reduced at moisture contents appreciably above the permanent wilting percentage.

Soil Characteristics Associated With Intake Rates

No single soil characteristic explains intake rates from either the infiltrometer or the core data. For the soils studied, volume weight, stability, swelling, effective pores and structure appear to best explain the variations within medium and moderately heavy textured soils.

Volume Weight: Within textural classes, volume weight appears to be the most important factor associated with both infiltrometer intake rates and core intake rates. Significant reductions in intake rates both at field moisture and at saturation occur when the volume weights are grouped by texture and classes of compaction (table 2). This table was developed empirically from nearly 2000 core samples taken in the Southwest. Note that the limits of each class of compaction, except the three heavier textures, vary with texture.

Table 2. Volume weight classes listed by texture and degrees of compaction for non-gravelly soils (tentative)

Texture	Classes of Compaction		
	Firm	Moderately Compact	Compact
Heavy (fine)	-1.25	1.26-1.45	1.46 +
Moderately heavy	-1.25	1.26-1.45	1.46 +
Medium (40% + silt)	-1.25	1.26-1.45	1.46 +
Medium (0 — 39% silt)	-1.41	1.42-1.52	1.53 +
Moderately Light	-1.45	1.46-1.64	1.65 +
Light (coarse)	-1.45	1.55-1.75	1.76 +

Tillage pans are readily recognized by the presence of horizontal shingle-like plates which are two to five times as long as they are thick. Compact subsoil layers are often characterized by a shellac-like sheen of colloidal coating on fractured aggregates when viewed at 20 power in direct sunlight. Compact soils are associated with much reduced intake rates.

Stability: Silt is clogging material, especially in medium-textured soils containing 40 per cent or more silt. Such soils, when moderately compact, are characterized by core rates at field moisture of one inch per hour and saturated core rates of less than .5 inch per hour. Under dryland conditions soils of this texture which are firm have intake rates which are appreciably higher. Medium textured soils containing less than 40 per cent silt have higher intake rates for comparable classes of compaction than those soils containing more that 40 per cent silt.

In addition to the percentage of silt, another good clue to stability is resistance to slaking as determined by a modification of McCalla's water drop method (6). Select an aggregate ⅛ to ¼ inch in size and record the number of drops of water required to slake it. Use ordinary one ounce eyedropper held at a height of approximately one inch above the lump. Medium textured surface soils which melted with 10 drops or less were bottleneck layers, whereas those melting with 11 to 25 drops had somewhat higher core rates than the tillage pan.

The percentage of dispersion of the .005 clay, however, was not correlated with stability. The percentage of dispersion varied from nine to 15 per cent for the surface soils from cultivated fields. Such soils are not usually considered to be dispersed, yet the water drop test showed that they were not stable.

The organic matter content of the medium textured surface soils varied from .9 to 1.5 per cent in the cultivated fields, except two fields which were especially selected because they contained 2.3 per cent organic matter. For soils of comparable volume weight and silt content, 40 per cent +, the core rates were similar to soils with lower organic matter content. Apparently, stability is not necessarily associated with the percentage of organic matter if the soils contain 40 per cent of silt within the range of organic matter contents studied (1.0 - 2.3 per cent).

Swelling: Using the core volume at field moisture as 100, we determined the per cent expansion of the core when saturated. First, a celluloid triangle was placed on top of a one inch ring above the soil sample. Next, water is added until the undersurface of the triangle is wetted. The decrease in volume required to fill the ring is equal to the increase in swelling. Later, we added to the volume of swelling the per cent shrinkage of the oven-dried cores. Swelling tends to offset the favorable structural characteristics of the moderately heavy subsoils, especially when such layers are at field capacity. The total percentage of swelling and shrinkage varied from 12 to 19 per cent for clay loam subsoils. In contrast, medium textured soils varied from three to ten per cent. The percentage of swelling per unit of clay was highest in the upper part of the B horizon. Differences in fineness of the clay fraction as well as type of clay are presumably related to swelling. Although all of the clay loam subsoils we studied in Colorado were slowly permeable, that was not true in New Mexico.

Effective Pores: To evaluate the effect of various sized pores a general relationship has been observed (5) and appears to be expressed as follows:

$$\text{Effective Pores} = \frac{\text{No. of pores } 1/40\text{—}1/20\text{" dia.}}{5} + \text{No. of pores larger than } 1/20\text{" diameter}$$

Based on the number of effective pores per square foot cross section, we found that less than ten were of little effect. Actually, an "effective" pore is very much in-

fluenced by the stability of the layer. Pores appeared to influence core rates more in moderately heavy layers than in medium textured layers containing more than 40 per cent silt. Saturated rates in excess of 1.0 inch per hour were obtained from fragmental clay loams containing more than 20 effective pores per square foot in spite of the fact that they were compact.

Structure: Both the surface soils and tillage pans in cultivated fields tend to be massive. Within this group, there was a wide variation in intake rates at both field moisture and saturation. In soil units 2M23, 2M24 and 3M27cl, the moderately heavy upper subsoil has cubical structure (Pullman, Rago, Platner) and is slowly permeable. In contrast, soil unit 2M34 (Dalhart) has a moderately heavy subsoil with both prismatic and fragmental structure which is moderately permeable. These layers also contained more than 10 effective pores per square foot. At moisture contents approaching field capacity we found it difficult to separate cubical from prismatic structure. As O'Neal (7) has pointed out, type of structure alone is not a sufficient basis for evaluating permeability.

The direction of natural breakage is helpful in recognizing tillage pans in soils which are massive. Natural breakage includes lengths of natural breakage for soils with massive structure as well as the axis length of individual aggregates (5). In general, when horizontal breakage predominates over vertical breakage you can expect slower permeability rates (5) (7). Likewise, when the overlap of aggregates (i.e. fragmental) is less than 25 per cent you can expect moderately permeable rates whereas 25 to 50 per cent overlap usually indicates slowly permeable soil.

Summary

A portable infiltrometer was used to simulate a storm of two inches in one hour on hardland wheat soils possessing medium textured surface soils in eastern Colorado and eastern New Mexico. Owing to instability of the surface soil there is a serious runoff problem on slopes of less than two per cent. More than twice as much runoff was measured from crusted soils as from good blue grama-buffalograss sod. Tillage pans, occurring at depths of from three to eight inches, are also a serious cause of runoff. Chiseling these tillage pans when dry reduced runoff appreciably from both initial storms and those made the following day. In contrast, chiseling tillage pans when nearly at field capacity reduced runoff during the initial storm because a new tillage pan was created. Additional studies are needed to determine the optimum moisture for breaking tillage pans.

Formulae are presented for predicting infiltrometer intake rates using core intake rates and the unfilled storage below field capacity and 80 per cent of the temporary storage.

Under present conditions with a tillage pan, limiting layers affecting intake rates are confined to the surface foot.

No single soil characteristic explains intake rates from either the infiltrometer or the core data. Volume weight, stability, swelling, effective pores and structure appear to be the most important factors influencing the intake rates of the medium and moderately heavy textured layers studied.

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Nature is not to be conquered save on her own terms. She is a very business-like old lady, who plays no favorites. Man is welcome to out-number and dominate other forms of life, provided he can maintain order among relentless forces whose balanced operations he has disturbed. But the hard condition is one that, to date, he has scarcely met. His own past is full of somber warnings—vanished civilizations buried, like dead flies in lacquer, beneath her own dust and mud.

—From Deserts on the March.

Recent Research Reviews

JAMES H. STALLINGS

The Reviews by J. H. Stallings that follow are a regular feature in the JOURNAL. It is hoped that the projects reviewed from time to time will be helpful to conservationists everywhere. Members of the Society are urged to indicate their interest in the kind of research work that should be reviewed.

Wringing Out a Spruce Bog. *By* JOHN V. HOENE; *Amer. Forests, Vol. 57, No. 3, pp. 20-21. March 1951.*

Controlled drainage may save millions of high quality Christmas trees now being drowned in inaccessible spruce bogs. A Minnesota forester reports good preliminary results from such an experiment.

Effect of Past Management and Erosion on Soil on Fertilizer Efficiency. *By* JOHN LAMB, JR., EVERETT A. CARLETON, *and* GEORGE R. FREE; *Soil Sci., Vol. 70, No. 5, pp. 385-392. November 1950.*

The purpose of this paper is to show the extent of erosion damage as reflected in yields under uniform cropping and management. It is shown that the productive capacity of soils is related to the degree of past erosion even though chemical nutrients are present in ample supply.

Causes of Poor Growth of Plants on Acid Soils and Beneficial Effects of Liming I. Evaluation of Factors Responsible for Acid-Soil Injury. *By* W. R. SCHMEHL, MICHAEL PEECH, *and* RICHARD BRADFIELD; *Soil Sci., Vol. 70, No. 5, pp. 393-410. November 1950.*

Two greenhouse experiments were conducted to determine the influence of the exchangeable Ca supply, soil acidity, Mn, Al, and Fe as factors affecting the growth of alfalfa on Mardin silt loam having a pH of 4.75 and containing 600 pounds of exchangeable Ca per 2,000,000 pounds of soil.

When the exchangeable Ca content was reduced to 150 pounds per 2,000,000 pounds of soil by diluting the soil with sand, the yield of alfalfa increased as much as 500 per cent. The growth of alfalfa on a peat-sand culture at pH 4.8 containing 500 pounds of exchangeable Ca was as good as that on the Mardin soil limed to pH 6.5 and containing 3,800 pounds exchangeable Ca per acre. The poor growth of alfalfa on the unlimed soil was, therefore, not due to the low exchangeable Ca supply in the soil or the low Ca content of the plants.

The application of gypsum to the soil at varying levels of exchangeable Ca and at different pH values not only failed to increase the yield of alfalfa but caused a reduction in yield when the soil was high in exchangeable Mn. The Mn and Al concentrations in the soil solution were greatly increased by the application of gypsum to the soil.

Thinning Over-Dense Jack Pine Seedling Stands in the Lake States. *By* EUGENE I. ROE *and* JOSEPH H. STOECKELER; *Jour. of Forestry, Vol. 48, No. 12, pp. 861-865. December 1950.*

This study was designed to study the effects of thinning jack pine seedlings at the ages of 5, 10, 15, and 20 years. Within each of three separate blocks, half-acre plots were thinned to 2 by 4-, 6 by 6- and 8 by 8-foot spacings. The results of the 5 and 10 year thinnings are discussed.

Sulphur and Calcium as Plant Nutrients. *By* VINCENT SAUCHELLI; *Amer. Fert. and Allied Chemicals, Vol. 113, No. 10, pp. 12-13 and 23. Nov. 11, 1950.*

This discussion deals with the role of calcium and sulphur as plant nutrients, and more specifically with their relation to the calcium sulphate component of superphosphate. It claims that this fertilizer, sulphate of calcium, is identical in its soil behavior with gypsum and that for all fertility purposes the several forms of calcium sulphate are equivalent as a source of calcium and sulphur nutrients and in chemical behavior.

Fertilizer Placement Machine for Experimental Plot Work. *By* GUSTAVE E. FAIRBANKS; *Agr. Eng., Vol. 31, No. 11, pp. 556 and 564. November 1950.*

The author describes a machine designed for the placement of fertilizer in experimental plot work. It is mounted on an International Harvester Model C tractor in connection with a C-221 corn planter. The corn planter is equipped with special split-runner-type furrow openers.

Practical Importance of a Medium Reserve of Alterable Minerals (Orthoclase) Under Temperate Climate (Belgium). *By* L. DE LEENHEER; *Trans. of the International Congress of Soil Sci., Vol. 2, Amsterdam. 1950.*

It was concluded that fertilizer tests carried out on experimental field plots have no scientific value, if these tests are carried out in fields: (a) for which no detailed pedological map has been made, (b) for which no pedological characteristics of the existing profiles are known. The difference in crop production, due to different fertilizers may constitute only a fraction of the difference in production that may be caused by the nature itself of the pedological profiles.

Relation of Moisture Equivalent to Field Capacity and Moisture Retained at 15 Atmospheres Pressure to the Wilting Percentage. *By* T. C. PEELE *and* O. W. BEALE; *Agron. Jour., Vol. 42, No. 12, pp. 604-607. December 1950.*

The results reported show that the field capacities of South Carolina soils can be predicted from their moisture equivalents by the equation, $Y = 2.62 + 0.865\ X$, in which Y is the field capacity and X is the moisture equivalent. The regression of wilting percentages by the plant method on percentage of moisture retained when soil is subjected to 15 atmospheres pressure over a cellophane membrane is expressed by the equation, $Y = 0.99 + 0.97\ X$, in which Y is the wilting percentage and X is the 15 atmospheres moisture percentage. Puddling caused an increase in the per cent moisture the soil retained when it was subjected to 15 atmosphere pressure. Available water capacities are given for a number of South Carolina soils.

Determining Water Requirements in Irrigated Areas from Climatological and Irrigation Data. *By* HARRY F. BLANEY *and* WAYNE D. CRIDDLE; *USDA-SCS-TP-96. August 1950.*

Modern irrigation has been practiced in some areas of the West for more than 100 years. During this period the science has advanced remarkably particularly with respect to structures used in storing, conveying and controlling irrigation waters. Unfortunately, improvement of methods and practices of applying water to the land has not kept pace with the development of irrigation structures. This is especially true in many of the older irrigated sections where farmers do not know how much water is required by the plants to produce a crop, nor how much water is delivered to their farms.

By using information available on water requirements, such as that set forth in this and similar reports, technicians can readily estimate how much water a farmer needs for his crops. Water-measuring devices requiring the application of simple engineering principles can be installed to determine the quantity of water actually delivered to the farm. This knowledge will make possible an evaluation of the losses occurring between the farm headgate and the plant roots. Such losses—frequently more than 50 per cent—can be materially reduced by improved water conservation practices.

Drainage Ditches Can Be Erosive, Too. *By* WILLIAM A. ALBRECHT; *Soil Conservation, Vol. 16, No. 6, pp. 141-142. January 1951.*

In 28 years the erosion within a ditch on the West Fork of the Grand River in Worth County, Mo., has cut the ditch from an original width of 20 to 25 feet to one of five to eight rods. It has hauled away from 10 to 15 acres of fertile soil per section of land through which the ditch originally went as a straight line. It also closed a highway. All this erosion cost says nothing for the additional troubles and increased soil losses impending, now that the stream is starting to meander and to cut its line.

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Book Reviews

PRACTICE OF WILDLIFE CONSERVATION. *By* Leonard W. Wing. *John Wiley and Sons, Inc., New York. 412 pp., illus. 1951. $5.50.*

A sound general textbook in wildlife management is the product of Leonard W. Wing's experience in teaching this branch of conservation on the college level. A well-balanced factual coverage of the many-faceted subject reveals the thoroughness of his experience. He has conscientiously dealt with the multitude of questions inevitably raised by students in this new field of learning.

"*Wildlife management is the branch of conservation that handles wildlife as an attribute of the land,*" says the first sentence in the book. Thus the theme is pegged to the modern principle that the land and all that live upon it are a unified whole, and the conservation of any part of these resources must consider all the others.

The relation of soil conservation to wildlife welfare is appropriately recognized. For example, erosion and silt control is set forth as an essential of successful management of stream fish populations. The influence of soil productivity on game and other wildlife abundance is cited. This is done without shifting the emphasis of the book from the wild animals themselves and the principles and techniques of their management.

A sound ecological basis for the subject is laid in the opening chapters, two of which deal with "*The Biological Base of Management.*" Two chapters on general techniques follow, then separate consideration of different classes or groups of game, fur-bearers, fish, and other kinds of wildlife. Individual attention is accorded the principle species in each group. Especially detailed and penetrating discussions of the legal and administrative aspects of conservation are provided in the concluding chapters.

Despite the author's announced intent to write the book for laymen and practicing conservationists as well as for students, it bears the unmistakable mark of the college text. The language, though simple, is plodding and matter-of-fact. Of course, it could hardly be otherwise, and have condensed so much information about so many topics into the space of one ordinary text.

A comparison to the ranking classic in the field, *Game Management* by Aldo Leopold, is hardly fair to either book, but can scarcely be passed over since the present author was the first student to receive his doctorate under the late Professor Leopold. Wing's *Practice of Wildlife Conservation* lacks the inspirational flair of the earlier pioneer work, but supplies many of the concrete facts which were unknown 15 years ago. While many of Leopold's generalizations were frankly speculative, Wing builds bit of information upon bit of information in a convincing manner which demonstrates a generation's progress in wildlife knowledge.

—Ben Osborn, *San Angelo, Texas*

AVAILABLE PHOSPHORUS IN SOILS OF COLOMBIA, SOUTH AMERICA. *By* Rojas Cruz, L.A. *Revista Colombia de Quimica (Bogotá, Colombia). 31: 7-17. 1951.*

This study compares the content of available phosphorus in various Colombian soils with that of soils in California. Soil samples used for this investigation were selected by H. Jenny who studied the large soil groups in Colombia and the rate of decomposition of organic matter in the tropics.

The author employed the analytical method developed by Bingham in which distilled water is used as an extracting solution in the proportion of one to ten of soil and water. Results are expressed in terms of the concentration of the solution. With minor changes in the proportion of the solution the same results are obtained but when the dilution is aumented they change considerably.

Bingham made pot experiments in the greenhouse and in the field for comparison with the data shown by chemical analysis. He used as indicator plants lettuce and barley and obtained in both cases identical results. According to the results of the field experiments on deficiency in elements, he classified the level of available phosphorus in the soils as follows: 1. less than 0.4 p p m deficiency in phosphorus and response on application of soluble phosphorus. 2.04 to 0.5 p p m uncertain response and 3. more than 0.5 p p m response only in few cases. Of the 135 Colombian soil samples analyzed by the author, 65 per cent of the surface soils were deficient in phosphorus.

The soils were grouped together according to their pH values and a relation was established between the pH and the concentration of phosphates in p.p.m. and the percentage of organic carbon. The author is of the opinion that the application of lime will increase the available phosphorus though in the majority of the cases applications of phosphorus may be needed at the same time.

EXPERIMENTS ON EROSION OF SOILS. *By* Fernando Saurez De Castro. *Summary of several investigations on conservation of soil and water during the years 1949 and 1950. Federación Nacional de Cafeteros (Chinchiná, Colombia, S. A.). Boletín Técnico No. 6. 1951.*

Erosion is the result of a disturbance caused by the action of man, of the natural balance between the factors causing the formation of soil and the destructive forces. To approach the problem in an adequate way it is necessary to obtain quantitative data which clarify

the real characteristics of the phenomenon under different conditions.

The paper gives a summary of data obtained by the Division of Experimentation of the Soil Campaign (*Division de Experimentacion de la Campaña de Suelos*) in two of their 21 projects under investigation. All of them deal with the quantities of soil and water lost in the coffee growing zone in Colombia and the elaboration of methods and techniques to conserve the soil and its fertility.

The run-off plots and their method of operation are described in the report. In addition, physical and chemical soil analyses of each plot are also given. The characteristics of the rains in the region are analyzed and some relations are established between them and the losses of soil in bare lots. Each of the several factors causing erosion are studied and the corresponding experimental data presented. All of them are summarized in comparative graphics.

The author shows the importance of this kind of study and stresses that the entire soil conservation program should be based on the use of agronomic practices and utilizing the mechanical one complementarily.

The booklet includes an appendice of 50 tables in which the data examined in the text are given.

LAND HUNGER IN MEXICO. *By* Tom Gill. *86 Pp. The Charles Lathrop Pack Forestry Foundation, Washington, D. C., 1951.*

"But the hour is late."—So does Tom Gill close his disquieting book, *Land Hunger in Mexico.* And the pronouncement rings like a death knell from a mission church across the manure-strewn streets of some parched pueblo and on into the denuded, gullied hills. No American reader can readily dismiss a feeling of ominous concern.

In his swift, powerful portrait of an agricultural nation on the verge of economic ruin, Gill is no journalistic prophet of doom. His picture is deep-etched with facts collected during 25 years of research in Latin America. His other book, *Tropical Forests of the Caribbean* is a standard, reference for the area.

The author is now chairman of the Subcommittee on Unexploited Forests of the United Nations, and of the Committee on International Relations for the Society of American Foresters. He has been an officer of the Charles Lathrop Pack Forestry Foundation since its beginning in 1930. Two years ago he represented Latin America at the Third World Forestry Congress in Finland.

Gill looks at Mexico as a complete conservationist: which is to say he takes a panoramic view of all the problems making up the crisis. He examines the people —their desperate love for the unproductive fields and abject villages—the utter confusion of their 54 native dialects. In turn, he focusses on the land, in agriculture, forestry and grazing. Then he covers the Mexican government's sometimes ill-advised scramble for water. Lastly, he treats of the task facing the land-hungry nation. And what a task!

Of twenty-five million Mexicans, half are illiterate. Only seven per cent of the slightly more than 2,000,000 square miles is cultivated. Hardly five per cent is regularly tilled. And, due to uncertain rainfall and farming methods, less than four per cent is harvested annually. While six per cent of the arable land gets enough rain to produce reliably, irrigation is practiced on one hectare (about 2½ acres) out of eight.

Yet there is no recourse for the Mexicans. They must live on what they have. More than three-quarters of them work the soil. With a small potential for industry, they must farm or be famished. This, on earth notably lacking in nitrogen, phosphorus and magnesium.

There is the deeply intrenched *milpa* system of shifting agriculture. The *campesino* strikes out from the impovershed fields near his pueblo. He hacks down a little piece of the forest and burns the magnificent sawlogs. For a year or two he tills the little patch—tills it to the death by erosion and leaching. Then, he moves along, chops down another square of trees, burns the wood and starts plundering the soil again. . . .

In spite of an exemplary piece of conservation legislation passed in 1948, the rape of the country's forests and soil continues. Fires, wasteful management and abusive farming methods have destroyed half of the original forests, while agencies set up to control such practices are winked at, under-budgeted and go begging for trained personnel.

The republic has attacked her monumental water dilemma largely from the downstream end. Several vast engineering programs pay scant heed to the storage capacity of improved soil structure and vegetation. Nearby are the silted-up water systems of the Aztecs who used similar tactics centuries ago—and failed. Not far away are the relics of the Mayans whose civilization reputedly washed away.

Gill's thesis furnishes little tangible hope for the foreseeable future, but it does offer a basic program for Mexican conservationists.

It would hinge on (1) a resource inventory; (2) formulation of an integrated program of resource use; (3) organization of a technical staff to administer the program; and (4) conservation education. In the latter phase, the author expresses great confidence in the demonstration technique as employed effectively by the United States Soil Conservation and Forest Services.

He believes that seeing with his own eyes, the *peon* may learn the truth. He is suspicious of the written and spoken word.

Meanwhile, the land south of the border *"is engaged in a race between education and disaster."*

—BERNARD A. ROTH, *Upper Darby, Penna.*

DESCRIPTION AND RECORDING OF VEGETATION UPON A STRUCTURAL BASIS. *By* PIERRE DANSEREAU. *Ecology 32(2): 172-229. April, 1951.*

THE RELATION BETWEEN CLASSIFYING AND MAPPING VEGETATION. *By* A. W. KUCHLER. *Ecology 32(2): 275-283. April, 1951.*

Two thoughtful reviews of the subject of mapping vegetation bring together in the same issue of *Ecology* most of the current thinking on a highly controversial subject of interest to many conservationists—especially those concerned with range, forests, or wildlife.

The divergent viewpoints of different workers with different scientific backgrounds and different objectives are carefully analyzed. The extensive list of references with each paper directs the reader to original sources on almost any system or method that might interest him.

The first-mentioned and more comprehensive discussion by Dansereau reviews approaches to the study of vegetation and considers fundamentals of description and classification. He considers at length the structural-physiognomic point of view and presents a new system of classification based on six series of criteria: (1) life-form; (2) size; (3) function; (4) leaf-shape and size; (5) leaf textures; and (6) coverage.

Although his system may be of little practical use in dealing with the local and specialized problems of practicing conservationists, his insistance, with certain other authors, that vegetation be characterized by its own features, and not by anything else that may or may not be closely related with it, is sound guidance.

Kuchler discusses four basic themes commonly found in classifications of vegetation: (1) regional; (2) physiognomic; (3) floristic; and (4) ecological.

He penetratingly recognizes the effect of the *purpose* of a classification or a map upon the end product—a point of particular importance to conservationists. "This purpose controls both classification and field observation to a considerable degree. The effect of a given purpose is often to emphasize certain features of the vegetation while neglecting or even ignoring othrs. . . ."

While the specialist may be expected to continue to work toward his own particular ends, if he is interested in the relation of his work to the broader scientific study of vegetation, he will gain from these papers a sound perspective of the subject.

—BEN OSBORN, *San Angelo, Texas*

MANUAL OF SOIL AND WATER CONSERVATION ENGINEERING. GLENN O. SCHWAB, RICHARD K. FREVERT, *and* KENNETH K. BARNES. *William C. Brown Company, Publishers, Dubuque, Iowa, 1950. 222pp. $2.30*

This is not, as the title suggests, a manual of engineering but rather a concisely prepared manual covering the elementary engineering steps necessary in establishing the more commonplace soil and water conservation engineering measures on farm lands. Prepared primarily for classroom and laboratory instruction of college students in agriculture and its related fields, the authors have stated its purpose is—"to bring up to date information which has been gathered through experience and research and to compile the latest references, rather than to replace present textbooks."

Three chapters briefly cover simple surveying and its application to field problems. Individual chapters on contour lines, terraces, waterways, farm ponds, field drains, sprinkler irrigation, and use of explosives briefly treat with planning and layout. Besides some 90 illustrations, numerous tables, and approximately 100 references to publications and texts, each chapter contains one or more detailed laboratory problems which have been developed over a period of years and used in teaching at Iowa State College.

Experience has shown that engineering handbooks, when under conditions requiring no complex or special engineering treatment, have contributed materially in the successful establishment of thousands of contours, terraces, ponds, and field drains by nonengineering technicians. It is to be concluded that this manual, of similar content, should prove a welcome aid to the many other agricultural workers outside of the Service, such as vocational agricultural teachers, county agents, contractors, and individual farmers who must frequently cope with soil and water conservation problems without the aid of the simpler procedural steps outlined in the manual.

—E. W. GAIN, *Upper Darby, Pa.*

PARTNERS WITH NATURE. *By* IVAH GREEN. *Published by The Haddon Craftsmen, Inc., Scranton, Pennsylvania. 1950.*

This new book is for boys and girls, but it is a book that might well be read by many adults, especially those who are interested in conservation education in our public schools. It was written by a woman who knows boys and girls as well as she knows that conservation education is a major problem of this decade. Miss Green is State Supervisor of some 5,000 one-room rural schools in Iowa. Through her work she has become thoroughly familiar with the difficulties educators are encountering as they attempt to teach conservation of natural resources

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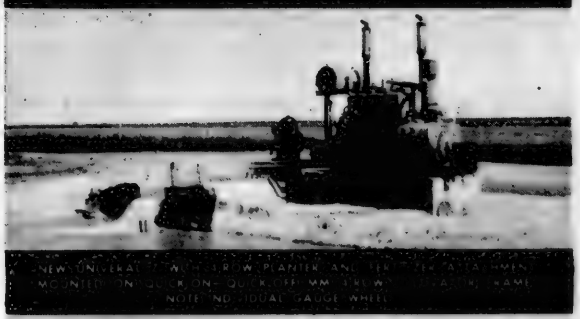

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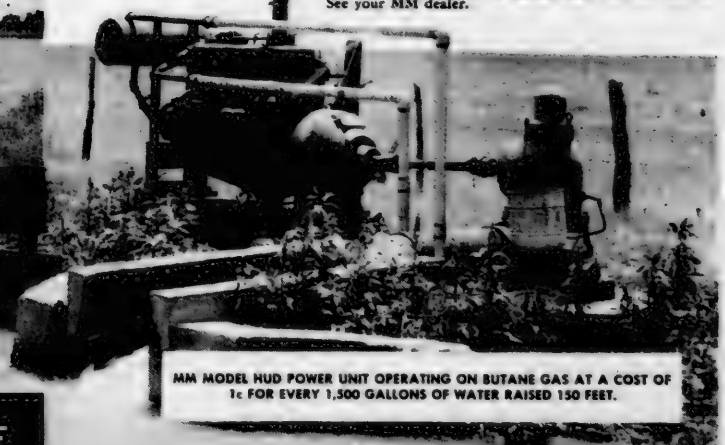

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to high school and college students who have no background knowledge of such subjects. Along with many other top-line educators, she is convinced that if we want our children of today to be conservationists of the 1960's and on, we had better see that they begin training early when all their instincts are alert to the world of Nature about them. *Partners With Nature* was planned and written for the specific purpose of helping along this important educational endeavor.

The book is so skillfully done that even the most obdurate youthful rejector of textbooks would scarcely hold out against it. The hibernating toad, bumblebees winning the Boer War, the 50,000 earthworms living in an acre of ground, the farmer and the soil and the corn kernel working together to make sugar and starch, bacteria causing dead plants to decay—all these become story characters in the child's mind. Then, the main chapter, "Help Nature By Saving Soil and Water," comes as a reasonable and natural climax to the text. The author has succeeded admirably in making soil and water 'alive' and the basis of all life. It is chiefly for this reason that *Partners With Nature* is suggested as a valuable book in the home or in school for children of the 1950's—because it doesn't thrust conservation techniques at them without first giving them understanding of Nature's plan and their place in it.

Beginning with fascinating accounts of small wild creatures adapting themselves to their environment in order to keep alive, it progresses smoothly through the plant-animal-people relationship and gently glides into the consequences of destroying the balance of Nature through misuse of land and water, not only to people but to all other living creatures. With great insight into the child's mind, the author weaves into the pattern the hydrologic cycle, soil organisms, formation of plant tissues, and other scientific truths usually omitted when writing for children.

—PHOEBE O'N. FARRIS, *Washington, D. C.*

Recommended Books

Bernhard Edward Fernow. *A Story of North American Forestry. By* ANDREW D. RODGERS III. *Princeton University Press, Princeton, New Jersey. 623 pages. 1951. $7.50.*

Principles of Human Geography. *Sixth Edition. Revised by* EARL B. SHAW. *John Wiley & Sons, Inc., New York. 805 pages. 1951. $6.25.*

Uncle Sam's Acres. *By* MARION CLAWSON. *Dodd, Mead & Company, New York. 414 pages. 1951. $5.00.*

Powell of the Colorado. *By* WILLIAM CULP DARRAH. *Princeton University Press, Princeton, New Jersey. 426 pages. 1951. $6.00.*

The Living Soil. *By* E. B. BALFOUR. *The Devin-Adair Company, New York. 270 pages. 1950. $4.00.*

The Conservation of Ground Water. *By* HAROLD E. THOMAS. *McGraw-Hill Book Company. 327 pages. 1951. $5.00.*

Fundamentals of Soil Science. *By* C. E. MILLAR AND L. M. TURK. *John Wiley & Sons, Inc., New York 510 pages. 1951. $5.00.*

Forestry in Farm Management. *By* R. H. WESTVELD *and the late* RALPH H. PECK. *John Wiley & Sons, Inc., New York. 340 pages. 1951. $5.00.*

Principles of Weed Control. *By* GILBERT H. AHLGREN, GLENN C. KLINGMAN *and* DALE WOLF. *John Wiley & Sons, Inc., New York. 368 pages. 1951. $5.50.*

New Conservation Films

Modern Farm Machines Bring Back the Range. *Color with Sound. Running Length 20 Minutes. J. I. Case Company, Educational Division, Racine, Wisconsin.*

A full color sound movie covering reclaiming rangeland of the West as advocated by the USDA Forest Service and the Soil Conservation Service. Illustrates proper use of equipment in breaking the land, seeding, combining grass crops for seed and the results of proper management and range improvement practices.

Willing Acres, *60 minutes, sound-color film, sponsored by The Keystone Steel and Wire Company, Peoria, Illinois, and produced by The Venard Organization of Peoria.*

While primarily concerned with the conversion-to-grass angle of soil conservation, the film shows that crops such as cotton, corn, and tobacco may also be produced profitably by practical land use. The story emphasizes the fact that farm women are quick to recognize what practical land use can do to bring about better living conditions for the family.

The educational message is tied together with a heartwarming story of folks in one community . . . the telephone operator who knows all and tells most of it . . . Fred Sanders, who lived on a farm and left it . . . and the girl and the farm he came back to.

Because soil conservation is your business

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One relentless enemy of farmers is erosion . . . because it steals valuable topsoil. Terracing, among other conservation measures, helps prevent erosion. And terrace building is a simple job on any farm with the new tractor-mounted, finger-tip-controlled, lightweight Ferguson disc plow. Other Ferguson implements make light work of many more soil-conservation practices.

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If farmers in your community are troubled by hardpan (created in part by heavy farm equipment), drought or erosion, you can help them by co-operating with your local Ferguson Dealer in his continuing effort to educate farmers on the value of lightweight equipment as a conservation measure. Harry Ferguson, Inc., Detroit 32, Mich.

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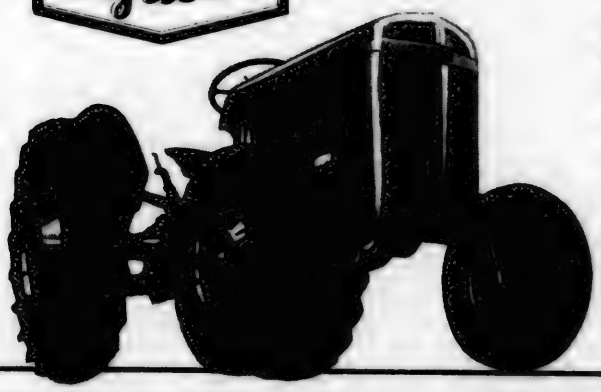

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FIELD NOTES AND COMMENTS

Non-farm Erosion Problems Often Neglected by Engineers

When one talks of gulleys and soil erosion one naturally assumes he is referring to agricultural land and inefficient farming practices. It never comes to mind that people, other than farmers, are responsible for soil erosion and land other than farm land, does have erosion problems. The problem is never as prevalent on non-agricultural land but nevertheless it does occur quite frequently.

The culprits aren't farmers or herdsmen but are engineers and construction men. The picture entitled *"Before"* was taken on the down stream side of a 3½ million dollar reservoir ten years after construction. In building the reservoir, money was no object and the finest materials and best workmanship were used throughout. But no one thought or planned what to do with relocated streams, drainage ditches or runoffs outside the immediate reservoir area. The picture bears this out. Only after ten years and after tons of soil were washed away and banks undermined did the city take cognizance of the erosion problem. The engineers and construction men responsible for this condition had long since departed so the local soil conservation district technician was called in to solve the problem. The picture labeled *"After"* shows how he is going about his job to make the water walk off the land instead of run off.

Figure 1. The "Before" and "After" scenes shown above were taken on the down stream side of a 3½ millon dollar city reservoir. Channel erosion was severe during the first ten years—top photograph. The bottom photograph shows what was done to correct the problem. The reservoir site embraces a complete watershed of 9,600 acres and is under a complete soil and water conservation plan.

It appears too often in construction jobs that even elementary soil conservation practices are ignored. *It may be that engineering courses should include a course of basic soil conservation principles.*

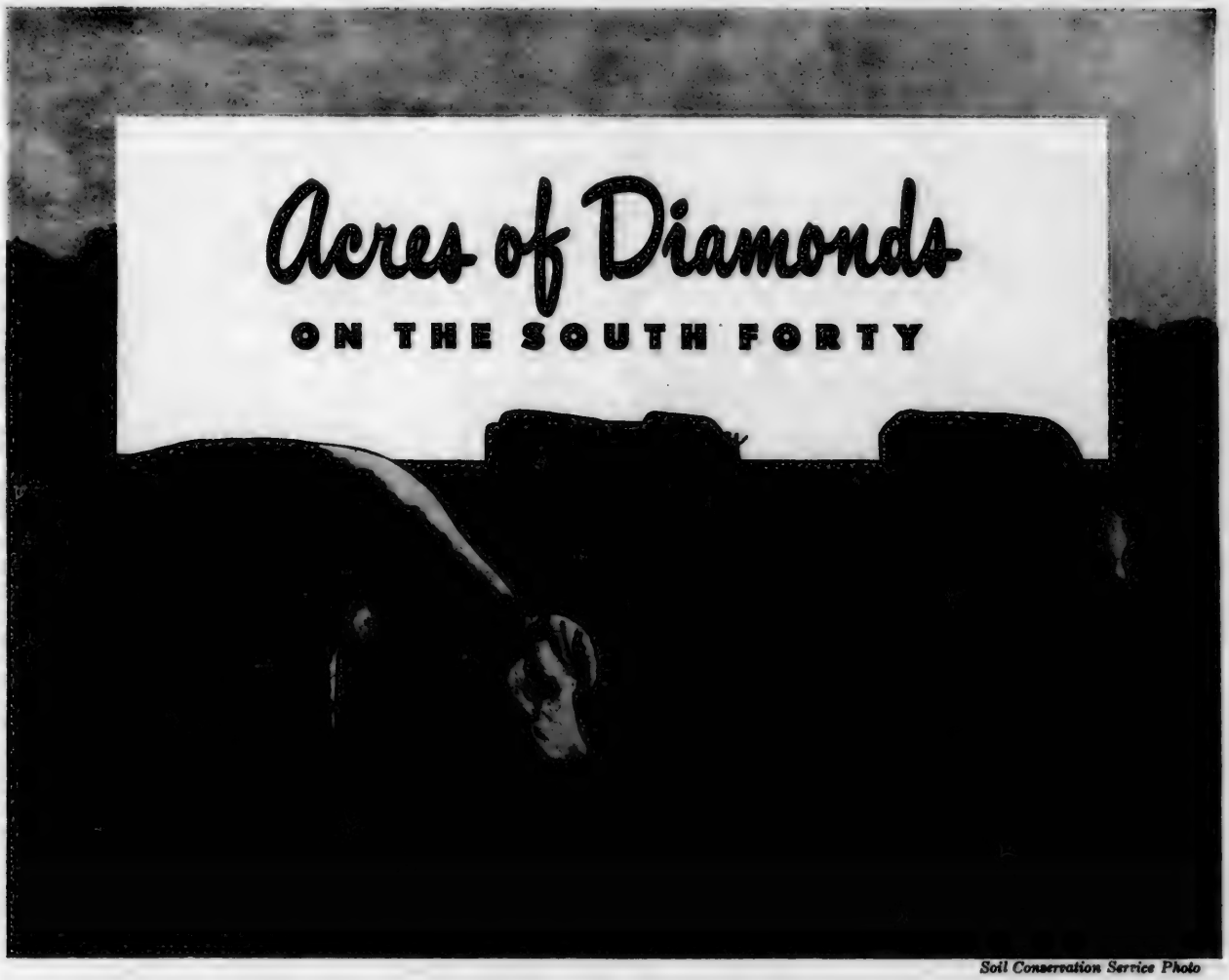
—Harvey R. Frantz, *Bethlehem Penna.*

Income Tax Deductions for Conservation Costs

For more than a generation federal and state conservation agencies have been urging private landowners to reforest idle acres, undertake soil conservation practices or practice wildlife management. "Why don't more people plant trees?" the technical foresters asked each other. Common sense would indicate that woodlots and streambanks should be fenced from cattle but farmers seldom bothered. Too few foresters, soil conservationists and game management men realize that the practices they advocate require considerable investments by landowners and are not even tax deductible. For this lack of realism in our conservation programs we in America have already paid too big a price.

In order to obtain a wider application of soil, forest, water and wildlife conservation practices on privately owned lands, an increase in investment expenditures for reforestation, soil erosion, streambank planting, wildlife shrubs, etc., is essential. Under present federal income tax laws and regulations such expenditures are generally treated as capital investments and hence are not deductible in the year made. They may be depreciated over a period of years but the life of such conservation measures is difficult to determine. Few landowners are encouraged to undertake them because there is little or no returnable income from increased production.

Yet, new forests on bare slopes, terraced and contoured fields and stabilized streambanks contribute to the public interest as well as private. The public benefits in improved ground water supplies, reduced siltation, increased wildlife production and conserved soil fertility are generally of greater long term social value than they are private. Private incomes derived are usually postponed for a long time in the case of tree plantings. Soil conservation measures result in only a small significant



Soil Conservation Service Photo

Fortunes lie waiting in many a 40-acres—waiting for someone to stir the soil a little better, manage it a little wiser.

The picture above suggests a case in point. On this 232-acre Mississippi farm, there are only 5 acres of row crop—corn for a little feed and meal. The other 227 acres are divided into eight different pastures—a variety of grasses and legumes and oats for grazing, all heavily fertilized for maximum production. When the cattle can't keep up with the grass, the owner takes off a crop of seed—"gold" in anybody's money. The owner began changing over to grass 8 years ago. Now the farm carries about a hundred of those whitefaces, old and young. The owner expects it to carry 60 mature cows, plus the young stock, when his grass plan really gets going.

Or consider the Indiana farmer who made eroded, broom sedge land bloom—by using lime, fertilizers, ladino clover, red clover, timothy, redtop, alta fescue, and orchard grass. Now, on land where locust sprouts vied with poverty grass 4 years ago, an acre will carry a dairy cow through most of the season. This Hoosier dairyman already has reclaimed 50 acres of such "worthless" land, is working on his second 50.

A cow to the acre! Acres of diamonds, indeed!

JOHN DEERE

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increase in crop production to the farmer, but they may be necessary to save his farm from complete loss by erosion. Conservation investments are, then, largely maintenance and repairs on a deteriorated resource undertaken after years of negligence and hence are accumulated expenditures. Present income tax regulations which treat these as non-deductible capital investments are therefore penalizing conservation incentives.

Taxation can be a means either of encouraging or discouraging conservation activities. Because conservation measures of privately owned lands have many public benefits of a long term nature, expenditure so made should be deductible in the current year's income taxes of the landowner, rather than be treated as a capital investment to be depreciated over a period of years as under present laws, the cost of specified conservation practices on the land should be deductible in the year made. To prevent abuse, only specified practices should be approved and a maximum limit placed on the expenditures allowed per acre.

The maximum expenditures allowed should be set at about $25 per acre for the first investment with a $5 per acre maintenance cost allowed annually thereafter for continuing conservation works in effect. Technical approval of the completed measures by competent state, federal or private conservationists should be attached to the income tax return to prove satisfactory performance.

The following types of land and water conservation measures should be included in any list of approved practices:

Forestry	Soil
Reforestation	Terrace Building
Windbreak planting	Grassing waterways
Fencing to exclude livestock from woods	Diversion Ditches
Underplanting of understocked woods	Filling Gullies & Building check dams
Forest insect and disease control	Stabilizing streambanks
Wildlife Conservation	**Water Conservation**
Fencerow planting	Fencing and Planting Headwater Springs
Planting Wildlife Shrub Patches	Building Farm Ponds

Obviously any payments received by the landowner from the U.S.D.A. Production and Marketing Administration, Agricultural Conservation Program should be deducted from the total of conservation expenditures before these in turn could be deducted from total income.

It is entirely probable that a great many owners who now hesitate to make the investments needed to put conservational management in effect on all their lands will do so under this procedure. Private expenditures on private lands which yield public benefits deserve special treatment which they do not now get. Conservation organizations would do well to pursue this issue until regulations are issued to provide for this situation. A speed-up in the application of remedial measures should be the outcome of this action.

—CHARLES H. STODDARD, *Minong, Wisconsin*

Letters to the Editor

Some New Ideas for the *Journal*

Dear Mr. Gumbel:

May I offer a few suggestions as to types of articles for the JOURNAL which would keenly interest me? As a "non-technical" man, my thoughts are more along the "popular" vein; but perhaps you'll find them not too much out of line:

- Profiles—biographical and autobiographical sketches of outstanding men and women in our field, with emphasis on personal as well as professional aspects of their careers.
- First-hand experience stories of soil and water conservationists at work in the more exotic places of the world—in the Pacific islands, on the grasslands of South Africa, in the outback of Australia, etc., with more emphasis on local atmosphere, customs, living and operating conditions, adventures and so on.
- Articles on opportunities in the professions related to soil

May We Send You This Newest Soil Building Booklet?

AS A CONSERVATIONIST you will find this handy reference booklet a worthy addition to your file on soil improvement. Its less than twenty pages are literally packed with significant—and completely authentic—data on the importance of farm manure in maintaining and building the country's crop producing soil. In every sense, NEW IDEA has kept this latest literature on an educational plane. It is free of any advertising or direct reference to the Company's products. Its sole objective is to promote sound soil building practices—and better utilization of a valuable barnyard "crop"—in a concise, comprehensive and easy-to-read manner. A soundly prepared text that is acceptable to all.

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and water conservation—in public service, with promotional organizations, in private industry, in the field of research, journalism, et al.

- Regular departments—an expanded letters-to-the-editor section, columns on soil and water people in the current news, developments in equipment, machinery, gadgets, field clothing, schedules of conferences, conventions, exhibits, demonstrations of interest to our people, conservation photography, etc.
- Photos—more of them.

I hope that at least the expression of these thoughts may be helpful to you.

—BERNHARD A. ROTH, *Philadelphia, Pa.*

South Africa Publishing Erosion Study

Dear Mr. Gumbel:

I very much appreciate your complimentary remarks about "VELDTRUST," more especially since it is designed for the average reader and not for technicians.

The report of our Desert Encroachment Commission has now been completed and when it is published—under our conditions that will be in about four to six months' time—it should be one of the most up-to-date scientific works on erosion in South Africa. I have seen advance copies of the report and found it a fascinating document. A minority report by two very brilliant young botanists maintains that in our Karoo area—country very similar to the northern parts of Arizona—overgrazing has affected the vegetation to such an extent that there has actually been a climatic change. The meteorologists dispute this.

Your JOURNAL fills me with envy, for I often wish that we had only a fraction of your technical resources at our disposal in South Africa.

—T. C. ROBERTSON, *Editor* NATIONAL VELD TRUST, *Johannesburg, South Africa*

Statements in *Journal* Article Questioned

Dear Mr. Gumbel:

The article by Roy Simonson in the April issue of the JOURNAL, Volume 6, Number 2, page 63, was *very interesting.* It should help to keep us all well oriented. I do hope, however, that readers of the JOURNAL will recognize that several of the statements were personal opinions and at variance with most of the data from the state experiment stations. The following are examples:

"Past erosion has not reduced the productive capacity of Prairie soils generally but it does increase the cost of production."—*Page 66, paragraph 3, line 6.*

According to surveys sheet erosion is moderate throughout this area and generally erosion is severe on the steeper slopes. Also the results of a rather large number of experiments in the prairie area show that erosion reduces the productive capacity. (I know of only two experiments, one in Iowa and one in Indiana, that indicated the reverse.)

"Where the deeper horizons are not too high in clay, Gray-Brown Podzolic soils can be productive after erosion of the surface horizons."—*Page 66, paragraph 5, line 15.*

True but 'productive' is only a relative term and the term 'can be' implies a bit 'if.' The term I have often heard used for the productivity of the Gray-Brown Podzolics after erosion of the upper horizons is, "generally low," but here again it is only a relative term so should not be used.

"As with the Prairie soils, however, costs of production are increased slightly when the surface soil is lost."—*Page 66B, paragraph 5, line 22, last sentence.*

Most soil scientists, I believe, would agree that this is "slightly" an understatement. Most of the Gray-Brown Podzolics where erosion has removed the surface soil to the plow depth or more have been taken out of cultivation due to increased costs and decreased per acre yields.

"Taking the soil group as a whole, however, the productive capacity is greater now under use by mankind than it was in the original forest."—*Page 66, paragraph 5, line 22.*

This is unsubstantiated opinion and may not be in agreement with early yield data. Possibly Simonson considers that clearing and draining the land has increased productivity. If so, I would agree.

"Deterioration of the soils in some cases, as for example the depletion of fertility in Cheonozems and Prairie soils, has been beneficial to mankind."—*Page 69, paragraph 5, line 8.*

This is the "prize package" so to speak. I might agree if he had stated some limit as, for instance, the deterioration has been beneficial to mankind if it has not been allowed to progress below the point where profitable returns could be obtained by the use of fertilizer.

—NORVAL L. STOLTENBERG, *Lafayette, Indiana*

Journal of Soil and Water Conservation

Index to Volume 6

January 1951 to October 1951

ALLIS, JOHN A.: Conservation Farming on Experimental Watershed Increases Farm Income 200

ANDERSON, HENRY W.: Physical Characteristics of Soils Related to Erosion 129

BANNER, GILBERT: Criteria for the Evaluation of Conservation Organizations as Interest Groups 179

BEAR, FIRMAN E.: The Wrong Turn 75

Book Reviews

ACKERMAN, EDWARD A. AND WHITAKER, J. RUSSELL: American Resources—*Edward H. Graham* 151

AFFLECK, JOHN: Hedging and Hedging Plants for the South—*Paul Tabor* 102

ALLRED, B. W.: Practical Grassland Management—*W. T. White* 101

AMERICAN ASSOCIATION OF SCHOOL ADMINISTRATORS: Conservation Education in American Schools 105

AMERICAN FORESTRY ASSOCIATION: The Muskingum Story 105

BOONES, KENNETH, SCHWAB, GLEN O. AND FREVERT, RICHARD K.: Manual of Soil and Water Conservation Engineering 214

BRAUN, E. LUCY: Deciduous Forest of Eastern America 56

BRINK, WELLINGTON: Big Hugh. The Father of Soil Conservation—*Margaret Suhr Reed* 43

CARHART, ARTHUR H.: Water—Or Your Life—*Bernard A. Roth* 148

CHAPMAN, PAUL W., FITCH, FRANK W., JR., AND VEATCH, CURRY LAFAYETTE: Conserving Soil Resources—*Maurice Brooks* 45

CHAPMAN, HERMAN H.: Forest Management 105

COCANNOUER, JOSEPH A.: Weeds—Guardian of the Soil 56

DOANE, D. HOWARD: Vertical Farm Diversification 56

Experiments on Erosion of Soils—Fernando Saurez De Castro 212

FINK, OLLIE E. AND FORMAN, JONATHAN: Water and Man. A Study in Ecology—*Ben Osborn* 46

FITCH, FRANK W. JR., CHAPMAN, PAUL W., AND VEATCH, CURRY LAFAYETTE: Conserving Soil Resources—*Maurice Brooks* 45

FORMAN, JONATHAN AND FINK, OLLIE E., Water and Man. A study in Ecology—*Ben Osborn* 56

FRANK, BERNARD AND NETBOY, ANTHONY—Water Land and People—*Lloyd Partain* 48

FREVERT, RICHARD K., SCHWAB, GLENN O. AND BARNES, KENNETH: Manual of Soil and Water Conservation Engineering 214

GABRIELSON, IRA N.: Wildlife Management—*Douglas Wade* 101

GARNSEY, MORRIS E.: America's New Frontier, The Mountain West—*Paul Phillips* 50

GILL, TOM: Land Hunger in Mexico—*Bernard A. Roth* 213

GREELEY, W. B.: Forests and Men—*S. L. Frost* 150

GREEN, IVAH: Partners With Nature—*Phoebe O'N.* Farris 214

GRIMM, WILLIAM C.: The Trees of Pennsylvania 56

HUGHES, H. D., HEATH, M. E. AND METCALFE, D. S.: Forages: The Science of Grassland Agriculture—*Virgil Hawks* 150

HEATH, M. E., HUGHES, H. D. AND METCALFE, D. S.: Forages: The Science of Grassland Agriculture—*Virgil Hawks* 150

ISRAELSON, OLSON W.: Irrigation Principles and Practices 56

MCCULLOUGH SEED COMPANY: Farm and Grass Seed Manual. Compiled by WILLIAM E. WARD—*A. D. Stoesz* 48

METCALFE, D. S., HUGHES, H. D. AND HEATH, M. E.: The Science of Grassland Agriculture—*Virgil Hawk* 150

MEZERIK, A. G.: The Pursuit of Plenty 56

NETBOY, ANTHONY AND FRANK, BERNARD: Water, Land and People—*Lloyd Partain* 48

PLENARY MEETINGS. Proceedings of the United Nation Conference on Conservation and Utilization of Resources 105

PRATT, HENRI: L'Homme et le Sol—*Paul Phillips* 104

PRESIDENT'S WATER RESOURCES POLICY COMMISSION: A Water Policy for the American People. Volume I.—*Paul B. Sears* and *Robert D. Teters* 146

PETERSON, H. B. AND THORNE, D. W.: Irrigated Soils: Their Fertility and Management—*Fred Larson* 44

QUINTILIANO, MARQUES J.: Politico De Conservacae De Solo (Soil Conservation Policy)—*Fernando Suarez De Castro* 149

ROE, HARRY BURGESS: Moisture Requirements in Agriculture Farm Irrigation 56

SCHWAB, GLENN O., FREVERT, RICHARD K. AND BARNES, KENNETH: Manual of Soil and Water Conservation Engineering 214

SELECT COMMITTEE ON CONSERVATION: Report to the Ontario Legislature—*William R. Van Dersal* 47

SMITH, GUY-HAROLD. Conservation of Natural Resources—*E. H. Graham* 151

SMITH, RUSSELL J.: Tree Crops—A Permanent Agriculture—*Edward M. Simmons* 45

SOCIETY OF AMERICAN FORESTERS: Forest Terminology 56

THORNE, D. W. AND PETERSON, H. B.: Irrigated Soils: Their Fertility and Management—*Fred H. Larson* 44

TOMANEK, G. W. AND WEAVER, J. E.: Ecological Studies in a Midwestern Range: The Vegetation and Effects of Cattle on Its Composition and Distribution—*Ben Osborn* 148

TERRA DE, HELMUT: Climatological Changes and Soil Conservation in Mexico—*Alvaro Rodrigues* 149

VEATCH, CURREY LAFAYETTE, CHAPMAN, PAUL W. AND FITCH, FRANK W. JR.: Conserving Soil Resources: A Guide To Better Living—*Maurice Brooks* 45

WEAVER, J. E. AND TOMANEK, G. W.: Ecological Studies in a Midwestern Range: The Vegetation and Effects of Cattle on its Composition and Distribution—*Ben Osborn* 148

WHEELER, W. A.: Forage and Pasture Crops—*R. Y. Bailey* 102

WHITAKER, J. RUSSELL AND ACKERMAN, EDWARD A.: American Resources—*Edward H. Graham* 151

WING, LEONARD W.: Practice of Wildlife Conservation *Ben Osborn* 212

WILLIAMS, A. N.: The Water and The Power—*Paul Phillips* 148
BRILL, G. D. AND NEAL, O. R.: Conservation Effects of Crop Rotation on a Sandy Soil in Vegetable Production 187
BROWN, CARL B.: Sediment Steals Water Storage 92
CLYDE, GEORGE D.: Utilization of Natural Underground Storage 15
CLYDE, GEORGE D.: What Determines the Value of Water? 87
COHEE, MELVILLE H. AND THORNE, G. D.: Livestock and The Land Institute 175

Conservation

Conservation: A Social and Moral Problem—*Carl C. Taylor* 7
COOK, R. L.: Structure and Sandy Soils 31
COOKE, MORRIS LLEWELLYN: On Water Resources 10

Cover Crops

The Need For Cover Crops in Corn Belt Agriculture. *J. J. Pierre* 121
DIEBOLD, C. H.: Soil Layers Causing Runoff from Hard-Land Wheat Fields in Colorado and New Mexico 202

Drainage

Terrace Drainage of Almena Soils in Central Wisconsin. *A. J. Wojta, C. B. Tanner* and *R. J. Muckenhern* 71
DULEY, F. L.: Keeping the Dust Under Cover 34
ELDER, WILLIAM R.: Factors Affecting Rate of Water Intake in Texas Blacklands 195
JACOBSON, PAUL: Are Point Rows Necessary on Terraced Land? 172
MCINTYRE, ARTHUR C.: Wood Chips, Water and Soil 20
MUCKENHIRN, R. J., WOJTA, A. J. AND TANNER, C. B.: Drainage of Almena Soil in Central Wisconsin 70
NEAL, O. R. AND BRILL, G. D.: Conservation Effects of Crop Rotation on a Sandy Soil in Vegetable Production 187

Organic Matter

The Wrong Turn—*Firman E. Bear* 75
Wood Chips, Water and Soil—*Arthur C. McIntyre* 20
PIERRE J. J.: The Need for Cover Crops in Corn Belt Agriculture 121

Policy

Scientific Use and Development of Natural Resources 6

Professional

A Professional Man's Responsibility—*Fred A. Wirt* 26

Research

Recent Research Reviews. *James H. Stallings.* ..... 41, 99, 152 and 210
SAUER, E. L.: County Agricultural Resources Conservation Planning in Illinois 170
SIMONSON, ROY W.: The Soil Under Natural and Cultural Environments 63
SLATER, C. S.: Winter Aspects of Soil Structure 38
SMITH, R. M. AND VICENTE-CHANDLER, JOSE: Principles and Practices of Bench Terracing in Puerto Rico 134

Soils

Keeping the Dust Under Cover. *F. L. Duley* 34
Physical Characteristics of Soils Related to Erosion. *Henry W. Anderson* 129
Structure and Sandy Soils. *R. L. Cook* 31
The Soil Under Natural and Cultural Environments. *Roy W. Simonson* 63
Winter Aspects of Soil Structure—*C. S. Slater* 38
STALLINGS, JAMES H.: Recent Research Reviews ..... 41, 99, 152 and 210
SWAN, HAROLD J.: 1951 Kansas Flood Area 198
SWANSON, C. L. W.: Soil Management, Soil Sense and Soil Conservation 183

Surveys

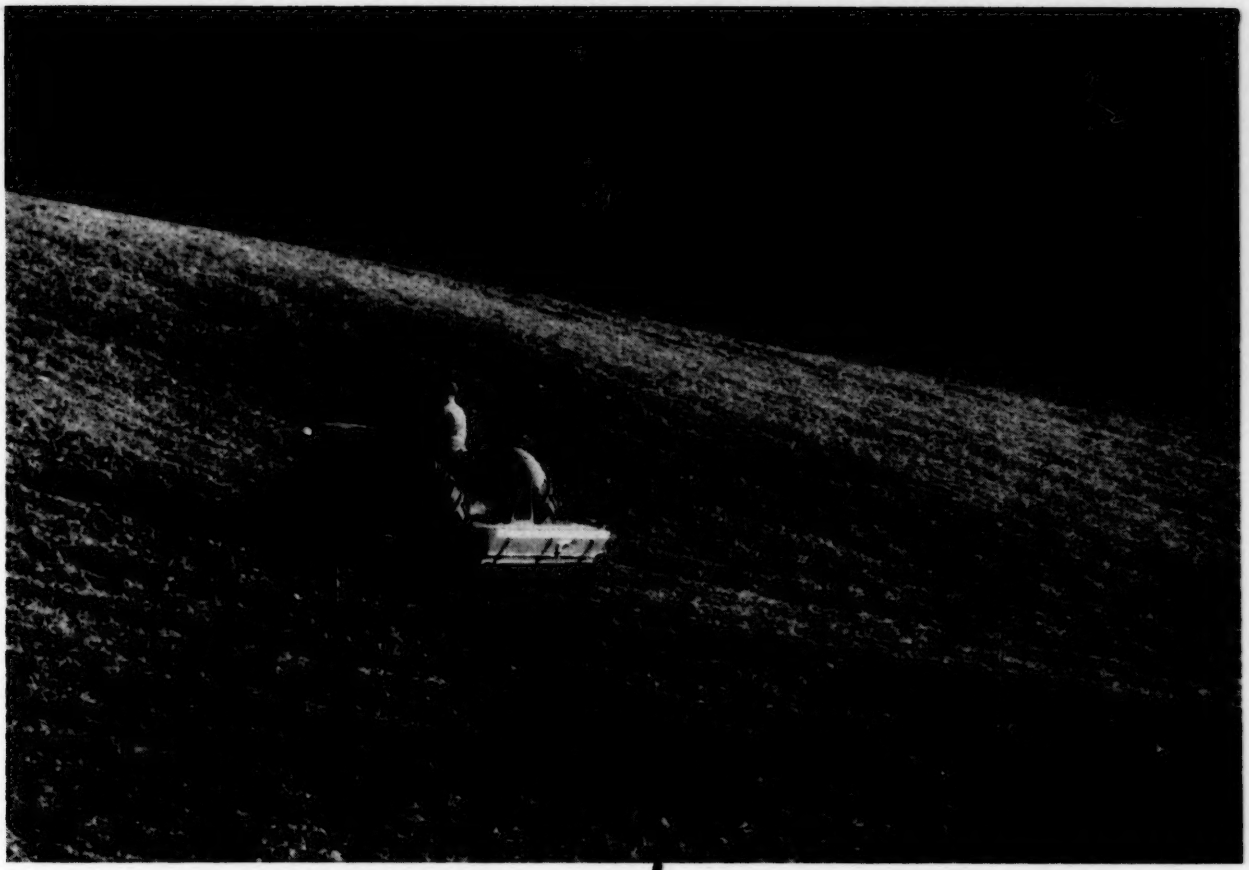
Soil Conservation Surveys do the Job—*Joseph H. Winsor* 125
TANNER, C. B., WOJTA, A. J. AND MUCKENHIRN, R. J.: Terrace Drainage of Almena Soil in Central Wisconsin 70
TAYLOR, CARL C.: Conservation: A Social and Moral Problem 7

Terracing

Principles and Practices of Bench Terracing in Puerto Rico. *Jose Vincenti-Chandler* and *R. M. Smith* 134
THORNE, G. D. AND COHEE, MELVILLE H.: Livestock and The Land Institute 175
VICENTE-CHANDLER, JOSE AND SMITH, R. M.: Principles and Practices of Bench Terracing in Puerto Rico 134

Water

On Water Resources. *Morris Llewellyn Cooke* 10
Sediment Steals Water Storage. *Carl B. Brown* 92
The Water Situation in the United States. *Joseph V. B. Wells* and *Adrian H. Williams* 78
Utilization of Natural Underground Water Storage. *George D. Clyde* 87
What Determines the Value of Water? *George D. Clyde* 87
WELLS, JOSEPH V. B. AND WILLIAMS, ADRIAN H.: The Water Situation in the United States 78
WINSOR, JOSEPH H.: Soil Conservation Surveys Do The Job 125
WILLIAMS, ADRIAN AND WELLS, JOSEPH V. B.: The Water Situation in the United States 78
WIRT, FRED A.: A Professional Man's Responsibility 26
WOJTA, A. J., TANNER, C. B. AND MUCKENHIRN, R. J. Terrace Drainage of Almena Soils in Central Wisconsin 70
ZWERMAN, PAUL J.: Problems of Drainage in a Soil and Water Conservation Program 185



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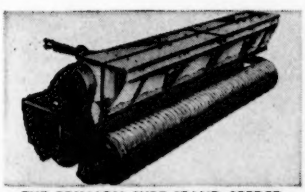

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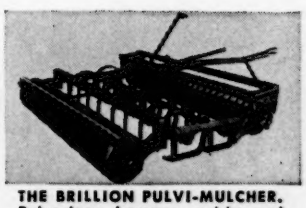

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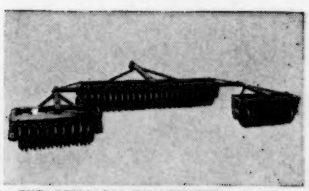

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